La Conférence intergouvernementale sur les précipitations acides

Actes de la conférence

Intergovernmental Conference on Acid Rain

Conference Proceedings

87-01796/

CONFÉRENCE INTERGOUVERNEMENTALE SUR LES PRÉCIPITATIONS ACIDES

QUÉBEC, les 10, 11 ET 12 AVRIL 1985

INTERGOVERNMENTAL CONFERENCE ON ACID RAIN

QUÉBEC, APRIL 10, 11 AND 12, 1985

ACTES DE LA CONFÉRENCE

CONFERENCE PROCEEDINGS

Publié par le ministère de l'Environnement en collaboration avec le ministère des Relations internationales du Québec

Published by the ministère de l'Environnement in collaboration with the ministère des Relations internationales du Québec

Dépôt légal - 1er trimestre 1986
Bibliothèque nationale du Québec
Bibliothèque nationale du Canada
ISBN 2-550-16042-8

Envirodoq 860055

Parrainée par

La Conférence des Gouverneurs de la Nouvelle-Angleterre et des Premiers ministres de l'Est du Canada

Sponsored by

The Conference of New England Governors and the Eastern Canadians Premiers

Co-présidents de la Conférence

Le Premier ministre du Québec, monsieur René Lévesque

Le Gouverneur de l'État du Massachusetts, monsieur Michael S. Dukakis

Co-Chairmen of the Conference

The Prime minister of Québec, René Lévesque

The Governor of Massachusetts, Michael S. Dukakis.

Organisateurs

Le ministère de l'Environnement du Québec
Le ministère des Relations internationales du Québec

New England Governors' Conference

Organizers

Ministère de l'Environnement du Québec
Ministère des Relations internationales du Québec

New England Governors' Conference

Nous remercions le Secrétariat des conférences intergouvernementales canadiennes pour leur contribution à l'organisation de cette conférence. Le Secrétariat a assumé également les services de traduction simultanée et le secrétariat de la conférence.

We wish to thank the Canadian Intergovernment Conference Secretariat for its contribution to the organization of this conference and particularly for assuming part of the logistics, the simultaneous interpretation services and the conference secretariat.

Origine de la Conférence

Lors de la 12e Conférence annuelle des Gouverneurs des États de la Nouvelle-Angleterre et des Premiers ministres de l'Est du Canada, les Gouvernements participants ont adopté une résolution prévoyant la tenue d'une Conférence intergouvernementale sur les précipitations acides à Québec au printemps 1985.

Cette conférence s'adressait, sur invitation, aux représentants gouvernementaux de sept provinces canadiennes et de quinze États américains.

Objectifs de la Conférence

- mettre en commun des informations sur les questions scientifiques et politiques associées au débat sur les précipitations acides;
- examiner les mesures susceptibles de faciliter le dialogue entre États et provinces sur les questions relatives à l'élaboration des politiques sur les précipitations acides;
- permettre de mieux comprendre les approches de différentes régions d'Europe et d'Amérique du Nord face aux précipitations acides.

Origin of the Conference

During the 12th Annual Conference of the New England governors and the Eastern Canadian Premiers, the participating governments adopted a resolution to hold an intergovernmental conference on acid precipitation in Québec City in the spring of 1985.

Government representatives from seven Canadian provinces and fifteen American states had been invited to this conference.

Objectives of the Conference

- to share information on scientific and political issues associated with the debate on acid precipitation;
- to examine possible steps in easing dialogue between states and provinces on issues relating to the elaboration of policies on acid precipitation;
- to better understand the approaches to acid rain of different regions of Europe and North America.

NOTE DE L'ÉDITEUR / EDITOR'S NOTE

Les communications sont présentées dans la langue dans laquelle elles ont été données. Un résumé français accompagne les communications de langue anglaise, un résumé anglais les communications de langue française. Veuillez prendre note que les résumés suivis de la mention E sont de l'Éditeur.

The papers are presented in the language in which they were originally given; however, a French abstract accompagnies the English papers while an English abstract accompagnies the French. Please note that abstracts identified with an "E" are from the Editor.

TABLE DES MATIÈRES/TABLE OF CONTENTS

CONFÉRENCES D'OUVERTURE /OPENING CONFERENCES — **PAGE**

Allocution d'accueil — 3
René Lévesque, Premier ministre du Québec

Welcoming Address — 11
Michael S. Dukakis, Governor of Massachusetts

PREMIÈRE SÉANCE/SESSION I — 21
EFFETS DES DÉPÔTS ACIDES/EFFECTS OF ACID DEPOSITION

Président/Chairman: Adrien Ouellette
ministre de l'Environnement du Québec

Influences of Atmospheric Deposition on Forest Ecosystems in the Northeastern United States — 23
Dudley Raynal, Ph.D.
College of Environmental Science and Forestry
University of Syracuse

Le dépérissement des érablières au Québec: problématique et état des recherches — 43
Lise Robitaille
Ingénieur forestier, M.Sc.F.
Ministère de l'Énergie et des Ressources du Québec

The Effects of Inhaled Acid on Human Health — 61
Dr. Morton Lippmann
Medical Center
New York University

PAGE

The History and Aquatic Effects of Acidic Precipitation in Northeastern U.S.: Evidence from Lake Sediments and Peat Deposit 75

Stephen A. Norton, Ph.D.
Department of Geology
University of Maine

Acid Rain and Aquatic Ecosystems: The Target Loading Question 91

Eville Gorham, Ph.D.
Department of Ecology and Behavioral Biology
University of Minnesota

Allocutions/Remarks 99

John A. Sununu
Governor of New Hampshire

John A. Fraser 107
ministre des Pêches et Océans du Canada

DEUXIÈME SÉANCE/SESSION II 115

Relations entre la science et l'élaboration de politique/ Science and Policy Relationships

Président/Chairman: Henri G. Williams
Commissioner of the
Department of Environmental
Conservation
New York

PAGE

Acid Precipitation Damage in Europe: Report on a Survey by the National Governors' Association 117

Anthony S. Earl
Governor of Wisconsin

The European Community: Actions to Control Acid Deposition 129

Jan Smeets
Division pour la prévention et le contrôle de la pollution
Communauté économique européenne

Findings and Conclusions of the U.S. and Canadian Peer Review Panels on U.S./Canada MOI Transboundary Air Pollution Reports 143

Hans C. Martin, Ph.D.
Senior advisor
LRTAP Liaison Office
Environment Canada

The Scientific and Economic Implications for Acid Rain Control 159

Tony Cortese, Ph.D.
Center for Environmental Management
Tufts University

TROISIÈME SÉANCE/SESSION III 199

INITIATIVES RÉGIONALES EN MATIÈRE DE PRÉCIPITATIONS ACIDES/ REGIONAL INITIATIVES ON ACID RAIN 201

Président/Chairman: Gérard L'Écuyer
ministre de l'Environnement et de la
Sécurité et Santé du milieu de travail
du Manitoba

PAGE

New England States 201
Wallace E. Stickney
Special Assistant for Environmental Affairs
Office of the Governor of New Hampshire

A Regional Perspective on Acid Rain: New York, Pennsylvania and New Jersey 209
Henry G. Williams
Commissioner of the Department of Environmental Conservation
New York

The Midwest - a Region of Diversity 217
Paul Guthrie
Director Intergovernmental Programs
Wisconsin Department of Natural Resources

Les initiatives des provinces de l'Est du Canada en matière de précipitations acides 243
Jean Piette
Directeur des stratégies et politiques environnementales
Ministère de l'Environnement du Québec

CONCLUSIONS ET OBSERVATIONS FINALES/CLOSING REMARKS 273

Adrien Ouellette 275
Ministre de l'Environnement du Québec

James Hoyte 281
Secretary of Environmental Affairs
Massachusetts

PAGE

CONFÉRENCE DE PRESSE/PRESS CONFERENCE 289

ANNEXES/APPENDICES 311

Programme/Program 313
Liste des participants/List of participants 315

CONFÉRENCES D'OUVERTURE/OPENING CONFERENCES

ALLOCUTION D'OUVERTURE DU PREMIER MINISTRE DU QUÉBEC

Monsieur René Lévesque

ABSTRACT

Mr. René Lévesque reminds the audience of the purposes of the Conference whose concern is to provide an opportunity to pool information on the political and scientific questions associated with acid rain and to examine the measures which are likely to encourage dialogue and action on this regard. Cooperation and dialogue between states, provinces and countries are essential to better understand the threat posed by acid rain. Furthermore, to reach a solution to the problem, it is indispensable that political and economic leaders become aware of the extent of the problem, the seriousness of what is at stake, and the corrective measures required and that there be a political will to act and to formulate novel and innovative solutions.

Recalling the vulnerability of the province of Québec, Mr. René Lévesque then outlines the measures undertaken to reduce acid forming emissions having their source in Québec and the actions already taken at an intergovernmental level. (E)

ALLOCUTION D'OUVERTURE DU PREMIER MINISTRE DU QUÉBEC
Monsieur René Lévesque

C'est avec à la fois enthousiasme et espoir que j'ai le plaisir d'ouvrir cette impressionnante conférence en compagnie de mon collègue co-président, le Gouverneur de l'État du Massachusetts, monsieur Michael S. Dukakis.

Enthousiasme parce que je constate l'intérêt remarquable des Gouvernements des États et des provinces situés de part et d'autre de la frontière pour ce problème environnemental sans précédent qui nous rassemble tous ici et qu'on appelle "précipitations acides".

Espoir parce que l'engagement d'un nombre croissant de dirigeants politiques dans notre pays, dans le vôtre et ailleurs dans le monde, nous permet d'entrevoir le jour où nous réussirons collectivement à mettre au point des mesures qui guériront notre environnement de ce mal qui l'accable.

Et ce n'est pas par hasard que la présente conférence a lieu au Québec, puisque notre propre territoire est justement l'un des plus vulnérables qui soient au monde à cette terrible corrosion.

Je me dois de souligner le fait que c'est, à notre connaissance, la première fois qu'un nombre aussi important d'États et de provinces du Canada et des États-Unis se réunissent pour se familiariser davantage avec les aspects scientifiques et socio-politiques de ce problème et pour échanger des informations et des points de vue à ce sujet. Je souhaite que ce ne soit pas la dernière parce que je suis convaincu que nous avons tous un rôle à jouer dans la mise au point des solutions à ce problème.

Je voudrais d'ailleurs saluer la délégation de l'État de l'Illinois qui avait invité le Québec, l'Ontario et le Manitoba à une rencontre intergouvernementale sur ce problème en avril 1984 à Springfield (Illinois).

En fait, la tenue de cette conférence témoigne de la ferme intention de nos Gouvernements d'assumer les responsabilités qui leur incombent dans le cadre des régimes constitutionnels auxquels nous appartenons. Nous voulons que notre voix soit entendue par les autres instances décisionnelles qui seront appelées à intervenir dans ce dossier.

Le problème des précipitations acides met en cause certaines des valeurs fondamentales de notre société, notamment les aspirations profondes de nos populations à jouir d'un environnement sain, la nécessité d'assurer la sauvegarde de nos ressources naturelles et la capacité de nos sociétés industrielles à maintenir leur dynamisme économique tout en relevant les défis technologiques et économiques que posent les précipitations acides.

Ce problème environnemental présente également un aspect inédit en raison de son caractère international qui justement, nous réunit tous ici aujourd'hui, et qui nous permettra de voir dans quelle mesure plusieurs États, provinces et pays d'un même continent pourront, sur une base de solidarité et de concertation, élaborer des stratégies communes visant à léguer un patrimoine naturel renouvelable aux générations futures.

Pour en arriver à cet objectif, je considère qu'il faut mettre de l'avant trois conditions fondamentales que je vais exposer brièvement.

Premièrement, il m'apparaît indispensable que tous les citoyens de nos pays, et notamment leurs dirigeants politiques et

économiques, prennent conscience de l'importance du problème, de la gravité des enjeux ainsi que des conséquences économiques liées aux dommages causés à l'environnement et aux mesures correctrices requises. À ce chapitre, je remarque une préoccupation croissante de nos populations pour ce problème et je crois que notre présence à cette conférence témoigne également du niveau de sensibilisation sans précédent de nos concitoyens et concitoyennes à l'égard de ce phénomène.

Deuxièmement, je considère que la concertation, les échanges et le dialogue entre États, provinces et pays sont essentiels à une bonne compréhension du phénomène et de tous les aspects qui lui sont reliés (effets, causes, impacts économiques...).

Troisièmement, je crois qu'une volonté politique de faire face au problème et d'élaborer des solutions originales et novatrices tant sur le plan technique, scientifique qu'économique, constitue l'autre condition qui est requise pour trouver une solution à ce problème. À ce chapitre, on a vu plusieurs initiatives louables dans différents états et provinces destinées à mieux faire connaître la question et à y apporter des correctifs appropriés à la source. Récemment, on a aussi vu le Président Reagan et le Premier ministre Mulroney nommer deux émissaires extraordinaires chargés de faire avancer ce dossier. Même s'il est encore trop tôt pour juger de la portée de cette initiative, elle démontre tout de même, je pense, une certaine volonté d'agir et de chercher une solution.

La tenue de cette conférence intergouvernementale s'inscrit dans une démarche qui rejoint les trois conditions dont je viens de faire état. Nous y sommes conviés pour mettre en commun des informations sur les questions scientifiques et politiques associées au débat sur les précipitations acides et à examiner les mesures susceptibles de favoriser et de faciliter le dialogue et l'action à ce propos. Les personnes qui ont été invitées à présenter des communications devraient nous permettre aussi de mieux comprendre la manière dont les

précipitations acides sont abordées dans différentes régions d'Europe et d'Amérique du Nord.

Enfin, pour ce qui est du Québec, notre position à l'égard du problème est étroitement liée à notre situation géographique sur ce continent. En effet, placé là où il est, dans le nord-est du continent, en aval des courants atmosphériques provenant de l'Ontario et des états du Centre-ouest et du nord-est des États-Unis, le Québec reçoit des quantités considérables de précipitations acides auxquelles il contribue d'ailleurs par ses propres sources d'anhydride sulfureux et d'oxydes d'azote.

Notre territoire, situé dans le bouclier canadien, n'offre pratiquement pas de capacité-tampon à l'acidité qui nous tombe du ciel, ce qui rend nos écosystèmes terrestres et aquatiques très vulnérables. Les relevés effectués par le ministère de l'Environnement du Québec nous indiquent que nous recevons des précipitations qui sont jusqu'à trente fois plus acides que des précipitations normales, et des quantités de sulfates humides qui atteignent 40 kilogrammes/hectare/année dans certaines régions, ce qui est le double du niveau que nous jugeons acceptable.

Devant les dangers d'acidification de notre milieu et devant les perturbations majeures qui touchent certains de nos écosystèmes forestiers, nos concitoyens connaissent l'importance du fléau et de la nécessité de s'y attaquer à la source, en concertation avec les autres Gouvernements concernés à la fois comme victimes et comme émetteurs de polluants.

Partout au Canada d'ailleurs, la prise de conscience populaire est telle que le dernier sondage Gallup démontre que la majorité des gens est d'accord pour débourser des sommes d'argent supplémentaires pour vaincre les précipitations acides.

Le Québec a joué un rôle de premier plan depuis plusieurs années en ce qui concerne la coopération intergouvernementale dans ce domaine, tant dans le sens nord-sud que dans le sens est-ouest, et il multiplie ses échanges pour mieux mesurer l'ampleur du problème, pour mieux en déterminer les causes et pour y apporter les solutions appropriées.

Mais surtout, nous sommes passés à l'action en lançant un programme visant à réduire nos propres émissions de 465 000 tonnes métriques d'anhydride sulfureux, d'ici la fin de la présente décennie. Les règlements destinés à mettre en oeuvre ces mesures d'assainissement ont été adoptés officiellement le 6 février dernier et sont en vigueur depuis le 9 mars dernier.

Selon ces règlements, l'effort d'assainissement des émissions d'anhydride sulfureux devra être assumé prioritairement par l'industrie des métaux non ferreux, par l'industrie des pâtes et papiers et par les systèmes de combustion des entreprises industrielles et des institutions. D'autre part, de nouvelles mesures réglementaires ont rendu illégal l'enlèvement des appareils antipollution des automobiles au Québec, mesure qui vise notamment à contrôler les émissions d'oxydes d'azote.

Cet effort s'inscrit évidemment au programme d'assainissement de 50 pour cent des rejets d'anhydride sulfureux de l'Est du Canada convenu entre les sept provinces concernées le 6 mars 1984. Ce programme a fait l'objet d'un partage entre les provinces le 5 février dernier. Un plan de financement fédéral fut également adopté quelques semaines plus tard alors que l'état fédéral annonçait des normes d'émissions plus sévères pour les émissions d'oxydes d'azote provenant des automobiles.

Assurément, la route ne sera pas facile. Elle sera coûteuse pour beaucoup d'entre nous, y compris ici, au Québec, où il faudra que

le secteur privé et le gouvernement fédéral ainsi que celui du Québec investissent des dizaines de millions de dollars pour atteindre les objectifs d'assainissement établis.

Je demeure cependant convaincu que ce n'est qu'à ce prix que notre société pourra relever les défis inattendus qui résultent du type de civilisation qu'elle a choisi. Défis écologiques certes, mais défis économiques et politiques aussi puisqu'il s'agit de sauvegarder collectivement les richesses inestimables que sont les lacs, la faune, les forêts, le patrimoine bâti et les industries de ce continent.

BIOGRAPHIE

René Lévesque est né à New-Carlisle en Gaspésie. Il complète à Québec les études classiques entreprises à Gaspé et en 1944, il devient correspondant de guerre attaché aux Armées américaines.

Il poursuit sa carrière de journaliste de 1946 à 1960 pour Radio-Canada. Élu député du comté de Laurier en 1960, il devient successivement sous le gouvernement Lesage, ministre des Travaux publics et des Ressources hydrauliques (1960-1961) puis ministre des Richesses naturelles de 1961 à 1965 et ministre de la Famille et du Bien-être social en 1966. Il est en 1967 l'un des co-fondateurs du mouvement Souveraineté-Association, puis en 1968, du Parti québécois dont il devient président.

Il est élu, le 15 novembre 1976, Premier ministre du Québec. Réélu le 13 avril 1981, il remet sa démission comme Premier ministre, le 21 septembre 1985.

WELCOMING ADDRESS

Michael S. Dukakis
Governor of Massachusetts

RÉSUMÉ

Michel S. Dukakis fait part de ses préoccupations devant la menace que représentent les précipitations acides pour l'intégrité des ressources naturelles et informe les participants des dommages constatés dans les états américains du nord-est ainsi que des mesures de réduction qu'ont prises ou que s'apprêtent à prendre ces États. Les précipitations acides étant indiscutablement un problème national, il fait valoir la nécessité de traduire ces initiatives au plan national. Évoquant les inquiétudes des États pollueurs devant les coûts économiques que représente un programme d'assainissement, il expose les efforts menés pour élaborer un programme de réduction des émissions qui amènerait un partage équitable des coûts. Enfin, il fait appel à la solidarité des États et provinces et parle de la nécessité de convaincre les autres Gouvernements du danger que représentent les précipitations acides et de prendre conscience de l'injustice des dommages causés aux territoires voisins par les émissions polluantes. Il insiste également sur l'urgence d'amener les gouvernements nationaux à s'entendre pour une action concertée. (E)

WELCOMING ADDRESS
Michael S. Dukakis
Governor of Massachusetts

It is a great pleasure to be here today with my co-host, Premier Levesque, with three of my fellow governors and with the delegates of 21 states and provinces. We are here today to discuss acid rain - a phenomenon which threatens the integrity of the priceless natural resources that are central to the legacy we wish to leave to future generations.

Those of us who have been elected to positions of political leadership have a solemn responsability to do everything in our power to protect these resources from environmental threats. Acting on that responsibility, we must make periodic assessments of our natural resources balance sheets with the scientific community acting as our consultants. Over the last decade our consultants have not given us encouraging reports. In fact they have reported growing deficits in the balance sheets of our forests, water resources, and our favorable political relationship - which should lead us all to worry, for surely a deficit in the resources that are integral to our economic and social structure will erode our strength as nations and the quality of life our citizens enjoy.

The most recent debit on those balance sheets in the United States has been declining growth rates among several species of trees in widely scattered locations throughout our country.

In Vermont for example, hundreds and hundreds of maple trees have been cut down because they are affected by a mysterious disease whose symptoms are similar to the effects of drought, and yet there has been no drought. This disease causes young trees in the prime of life, trees that should be productive for decades, to deteriorate within two or three years of the first signs of decline. And Vermont is not

alone. The same kind of thing seems to be happening in my state, in Maine, New Hampshire and Georgia, and to an even greater extent in the Eastern Canadian provinces.

True, the forests of New England and Eastern Canada have not yet reached the stage of devastation currently experienced in Germany, which Anthony Earl will be describing to you in detail later today. But many suspect that we are witnessing the early warning signs of sudden and irreversible decline. In Massachusetts, where our forests are just coming out of the most severe gypsy moth and oak leaf tier attack in living memory, this kind of damage could be economically as well as ecologically devastating.

Now, the damage to our forests is a relatively new development, but the deterioration of our water resources is something we have been witnessing for many years. We are all aware of the loss of fish in the lakes regions of the Adirondack Mountains in New York, Ontario and in Scandinavia.

In Massachusetts today, more than a dozen streams that used to support vibrant trout populations have had to be removed from our spring stocking list. In the Quabbin Reservoir in central Massachusetts, the "acid bath" of spring snowmelt in 1984 caused up to 90 percent mortality in smelt eggs and last summer rainbow trout and landlocked salmon placed in test cages submerged in the reservoir's feeder streams perished within hours.

This same water that is acutely toxic to fish is the drinking water supply for metropolitan Boston. We are now spending over a million dollars a year to prevent dissolved lead and mobilized aluminum from entering our capitol city's tap water.

A recent survey done by over 1,000 Massachusetts volunteers identified acidified lakes, ponds and rivers in every county of my

state. Seventy-five percent of them are now known to be acid-sensitive, fourteen percent are on our critical list and five percent, for all practical purposes, are biologically dead.

In short, the situation has not achieved equilibrium as the EPA would have us believe. The fact is that damage is proceeding at an alarming rate.

Just one month ago the leaders of our two nations met in this beautiful city to discuss our common future. They discussed ways to strengthen our economies, promote international trade and ensure our common defense. Unfortunately, not much attention was paid to real solutions to the acid rain problem.

Of course we are pleased that high-level envoys for each country have been named and both Mr. Lewis and Mr. Davis have reputations for being doers, not studiers. But what did not emerge on March 17th was a firm bilateral commitment to the control of acid rain and associated air pollution through immediate and significant reductions of sulfur dioxide and nitrogen oxide emissions. Instead we got another study.

How many times must we be reminded that the role of science is to provide information, but making tough decisions to act, based on the best information available, is the job of policy makers? How much longer must we struggle as individual states and provinces to solve a problem which is national and international in scope? How many times must we point out that we cannot - no matter how much we do as states and provinces - control conditions in political jurisdictions over which we have no control?

I learned a long time ago the wisdom of the saying that "The race is not to the swift, nor to the strong, but to him who persevereth", and persevere we will. And I believe there are three indicators that our goal is within reach.

First, in the face of clear and convincing scientific evidence that acid rain and associated air pollution are causing damage to lakes, soils, forests, monuments, human health and the quality of life in North America, in Scandinavia and in Europe, there is growing acceptance that the environmental degradation is real.

Second, there is a growing acceptance on the part of the business community, especially the forest products industry, of the danger of allowing the raw materials of production to be eroded, and a realization that the cost of the clean-up increases with every year that we delay.

And finally, President Reagan and Prime Minister Mulroney have appointed two of their most trusted and experienced advisors to develop solutions to this international dilemma.

We, in the northeastern United States, have already made significant strides in the right direction. New York has passed, and Massachusetts will soon enact, state emission reduction legislation. Similar proposals are now pending in the legislatures in Maine and New Hampshire.

The New England governors agreed last summer to implement a region-wide cap. The Coalition of Northeastern Governors followed suit soon thereafter, and yesterday the joint New England Governors and Eastern Canadian Premiers Environment Committee proposed a bilateral, short-term SO_2 emission reduction program that will be considered by the governors and premiers in June.

But because acid rain is indisputably a national problem, these state and regional initiatives must be translated into the law of our respective countries. The air that we breathe and that regulates the sensitive chemistry of our forests, soils, waters and wildlife knows no political boundaries - state, provincial or national. The same kinds

of sulfur emissions that create our acid rain problem in the northeast are being inhaled by the citizens of Ohio, are obscuring visibility in Indiana and are contaminating lakes in the Rocky Mountains and the Sierra Nevada. In fact, sulfur emissions from copper smelters in Mexico are now raising serious concerns in the Southwestern U.S., another reminder that these pollutants respect no national boundary.

Now, we have been told repeatedly that controlling acid rain will cost a lot and the Premier referred to that in his remarks. But we in the Northeast, like you in Eastern Canada, already pay some of the highest utility rates in the nation in part because we have insisted that the fuels we burn be as clean as possible. What we also know, and what you know, is that we are paying a heavy price every day for uncontrolled pollution from other regions.

Now, I am a governor who knows what it is like to struggle with economic hard times as we had to in Massachusetts in the mid-seventies. I am sensitive to the concerns of polluting states, many of whom have had difficult economic times these past few years and have cited the cost of clean-up as a barrier to implementing a control program. And that is why I and my fellow governors have worked hard to develop a plan that will minimize the economic impact on the producing states, even if it means somewhat higher costs for our consumers.

In the United States House of Representatives three of my own congressmen, Congressmen Conte, Markey and Boland, have just filed legislation which goes a long way toward assuring that there will be minimal job dislocation and economic disruption in the coal-producing states. The Coalition of Northeastern Governors have endorsed an innovative financing mechanism of interest-free loans for emitter states. And the National Governors Association, under the leadership of Governor Earl, approved a strong resolution calling for a national control program that would include equitable cost-sharing. These are the building blocks of a foundation upon which we must continue to build the structure of a comprehensive control program.

Over a century ago one of our most famous sons of Massachusetts, Henry David Thoreau, had this to say about one of his favourite natural resources. "A lake," he said, "is the landscape's most beautiful and expressive feature. It is earth's eye: looking into which the beholder measures the depth of his own nature."

What measure of ourselves do we see when we look into a lake in Massachusetts, Quebec, or the High Sierras? Do we see a people who are destroying the resources that are fundamental to the economic vitality and quality of life of both nations? Do we see a people who are undermining the most precious resource of all, their own trust in each other and their spirit of cooperation and commonwealth? Or do we see two nations joining their best resources, working hard to solve a complex but clear threat to reverse the erosion of their common future?

Make no mistake about it, my friends, acid rain is the Silent Spring of the 1980's. It is the accelerating poisoning of every level of the environment in countries all over the world, in every season of the year. It took us 20 years to act on Rachel Carson's warning. We do not have 20 years before we act on acid rain. We do not have time to look behind us at what we have not accomplished. We must look ahead to the goal that is within sight. We must do everything we can to control pollution within our own states and provinces. We must reach out to others in our respective countries and help them understand the danger we face and the injustice of the damage we inflict on our American and Canadian neighbors. We must insist that our national governments delay no longer, and above all, make the kind of commitment to bold and decisive action that is long overdue.

We consider the matter before this conference extremely important. We want to thank Premier Lévesque and all of you here in this lovely province for your hospitality and for being such wonderful hosts to us. We are going to keep the pressure on and I know you are going to keep the pressure on. I hope that one of these days, in the not-too-

distant future, we can come back here and celebrate some victories on this subject as we move ahead together to deal with what is a very, very precious thing to us - that is, the environment - and all that it means to Canada, the United States and to our respective people.

BIOGRAPHY

Michael Stanley Dukakis was born of Greek immigrant parents on November 3, 1933 in Brookline, Massachusetts, where he has resided ever since. He was graduated from Brookline High School in 1951 and received a B.A. from Swarthmore College in 1955, earning highest honors in political science. He returned to Massachusetts to study law at Harvard, graduating with honors in 1960.

Michael S. Dukakis entered the Massachusetts House of Representatives in 1963. In eight consecutive years there, he sponsored many consumer, housing and environmental measures. He was the first legislator in America to introduce a no-fault automobile insurance bill. After a long four-year fight, the state enacted the nation's first no-fault system in 1971.

PREMIÈRE SÉANCE / SESSION I

EFFETS DES DÉPÔTS ACIDES/ EFFECTS OF ACID DEPOSITION

Président/Chairman

Adrien Ouellette
ministre de l'Environnement
du Québec

INFLUENCE OF ATMOSPHERIC DEPOSITION ON FOREST ECOSYSTEMS IN THE NORTHEASTERN UNITED STATES

DUDLEY J. RAYNAL, Ph.D.
College of Environmental Science
and Forestry
State University of New York
Syracuse

RÉSUMÉ

Le nord-est des États-Unis est une région réceptrice de dépôts atmosphériques. Les systèmes météorologiques dominants qui traversent les régions densément peuplées et industrialisées des États-Unis et du Canada transportent des polluants atmosphériques qui sont en grande partie responsables de l'acidification des précipitations et du dépôt de substances chimiques sous forme sèche ou humide. La région des Adirondacks, dans l'état de New York, est considérée comme particulièrement vulnérable aux effets des dépôts atmosphériques en raison de ses caractéristiques géographiques, météorologiques, géologiques, hydrologiques et biologiques.

L'auteur caractérise les intrants ioniques transportés par les courants atmosphériques vers les forêts de conifères et d'arbres feuillus du centre des Adirondacks et analyse les mouvements ioniques dans diverses strates de l'écosystème. Il aborde ensuite l'influence des dépôts atmosphériques sur le déclin des forêts et présente des conclusions fondées sur une étude des caractéristiques historiques de croissance des arbres effectuée par analyse détaillée des tiges.

Les études ont été menées à la Huntington Wildlife Forest, propriété forestière de 6066 hectares appartenant au collège SUNY des

sciences environnementales et forestières de l'Université de l'État de New York dans le comté d'Essex (44° de latitude et 74°13" de longitude). La surveillance des dépôts atmosphériques s'est faite dans le cadre du programme national des dépôts atmosphériques des États-Unis (NADP). Le pH moyen des précipitations, pondéré en volume, s'établissait à 4,15 durant la période 1979-1982. La concentration des principaux ions dans les précipitations se répartissait de la façon suivante: pour les anions, $SO_4 > NO_3 > Cl > PO_4$ et, pour les cations, $H^+ > NH_4 > Ca > Na > Mg > K$. L'analyse chimique des retombées à travers la voûte des arbres et du sol a révélé que les mouvements ioniques sont similaires pour les groupes de feuillus et de conifères, mais que les concentrations ioniques sont plus élevées chez les conifères. Pour démontrer dans quelle mesure la lixiviation des substances nutritives dans le sol représente une perte chronique, il faut évaluer le type de forêt, les caractéristiques du sol, le taux de remplacement des éléments nutritifs, de l'effritement minéral et de divers autres facteurs qui ont une influence sur la dynamique des matières nutritives.

Plusieurs études menées récemment dans l'est des États-Unis indiquent une diminution du taux de croissance des arbres. L'épinette rouge est en déclin sur presque tout son territoire naturel. En raison des limites de l'échantillonnage et de l'absence de données concluantes sur les sols et sur l'historique des groupes d'arbres, il est impossible à l'heure actuelle de déterminer si ce déclin de la croissance est attribuable ou non aux dépôts atmosphériques. Il faudra procéder à de nouvelles études et améliorer les techniques d'analyse si l'on veut déterminer les rapports entre la croissance des arbres et les dépôts atmosphériques. La méthode de l'analyse des tiges peut permettre d'obtenir les caractéristiques historiques de la croissance des arbres et d'évaluer par la suite l'effet des dépôts atmosphériques sur celles-ci.

THE EFFECTS OF ACIDIC DEPOSITION ON FOREST ECOSYSTEMS OF THE NORTHEASTERN UNITED STATES

DUDLEY J. RAYNAL, Ph.D.
College of Environmental Science
and Forestry
State University of New York
Syracuse

The Northeastern United States is a receptor region for atmospheric deposition. Prevailing weather systems that track over heavily populated pollutant-producing areas of the United States as well as Canada transport air pollutants that are largely responsible for the acidification of precipitation and for the deposition of a variety of chemical substances that fall out in both wet and dry form.

The Adirondack Mountain region of New York State is thought to be particularly susceptible to the influences of acidic deposition because of the character of its soil, water and biological resources. The influences of atmospheric deposition on aquatic and terrestrial ecosystems of the region are of great concern to natural scientists, private landowners, recreationists, governmental bodies, as well as to businesses and industries whose welfare depends upon the natural resources of the area.

This presentation addresses the chemical nature of acidic deposition of the Northeastern United States. Further, it seeks to evaluate the movement of chemical substances or ions through forest ecosystem strata and it also considers the possible role of acidic deposition in forest decline.

Atmospheric Deposition

In cooperation with the National Atmospheric Deposition Program (NADP) in which both the United States and Canada collaborate, we have measured the chemistry of snow and rainfall in the central Adirondack region at Huntington Wildlife Forest. Figure 1 shows the acidity (pH) of precipitation measured at the field station from November 1978 through October 1984. The volume-weighted mean annual pH was 4.15 during the period, some 50 times more acidic than normal rainfall (pH 5.6).

The primary acidifying agents of precipitation are oxides of sulfur and nitrogen. Figure 2 shows sulfate ion concentration and indicates that there are warm season maximal values of sulfate in precipitation. Figure 3 shows nitrate ion concentration during 1978-84 at Huntington Forest. Unlike sulfate, nitrate shows little seasonal concentration pattern. Taken together, sulfate and nitrate constitute approximately 95 percent of the total anionic strength of precipitation as depicted in Figure 4. Chloride ions constitute about 4 percent of the total anions and phosphate less than 1 percent.

Hydrogen and ammonium ions constitute about 62 percent and 19 percent respectively of the cations in precipitation at Huntington (Figure 5). Hydrogen ion concentration generally shows a spring and summer concentration peak (Figure 1); ammonium concentration follows a similar pattern. Calcium, sodium, magnesium, and potassium comprise the remaining cations.

Scientists are interested not just in the concentration of these ions in precipitation, however, but also in the deposition of ions, the total amount of sulfur and nitrogen and other substances that our natural and man-related ecosystems receive. Because precipitation in the Adirondacks is rather evenly distributed throughout the year, trends in ionic deposition are influenced to a greater extent by ionic

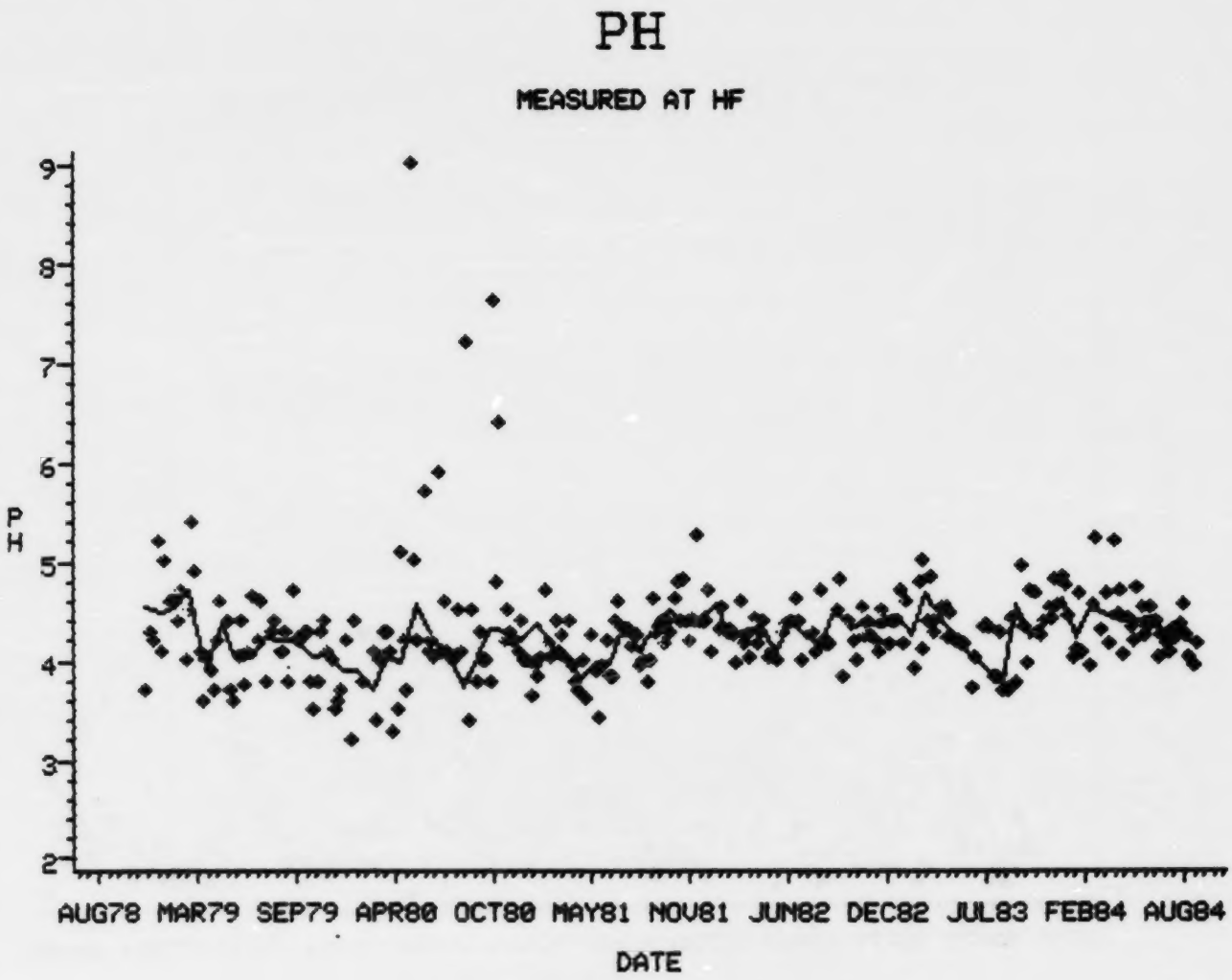


Figure 1. Symbols show pH of weekly precipitation samples at Huntington Wildlife Forest, Nov. 1978-Oct. 1984. The volume-weighted mean monthly pH of precipitation is plotted through the sample points. The pH measurements were made on site.

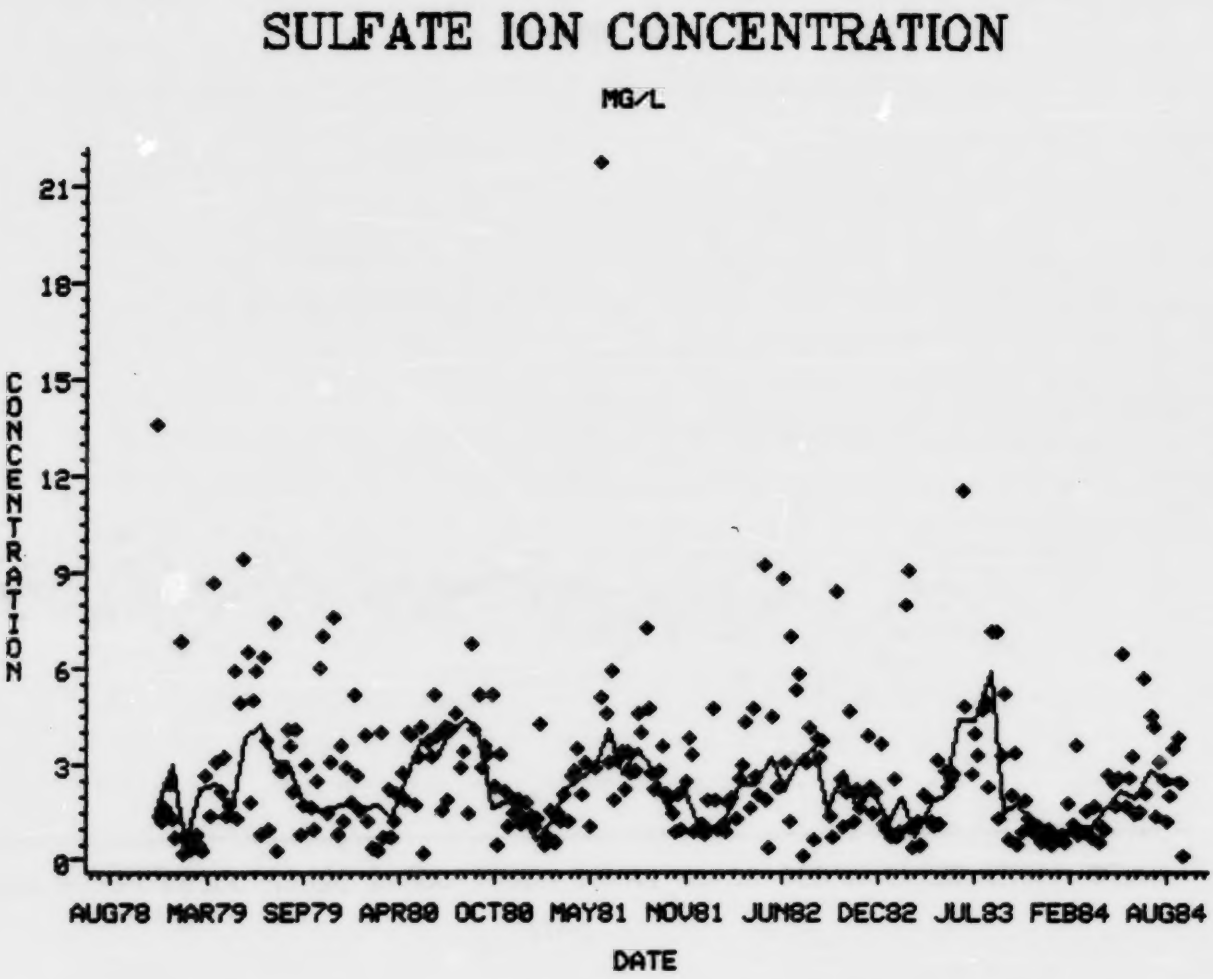


Figure 2. Symbols show sulfate ion concentration (mg/l) in weekly precipitation samples at Huntington Wildlife Forest, Nov. 1978-Oct. 1984. The volume-weighted mean monthly sulfate ion concentration is plotted through the sample points.

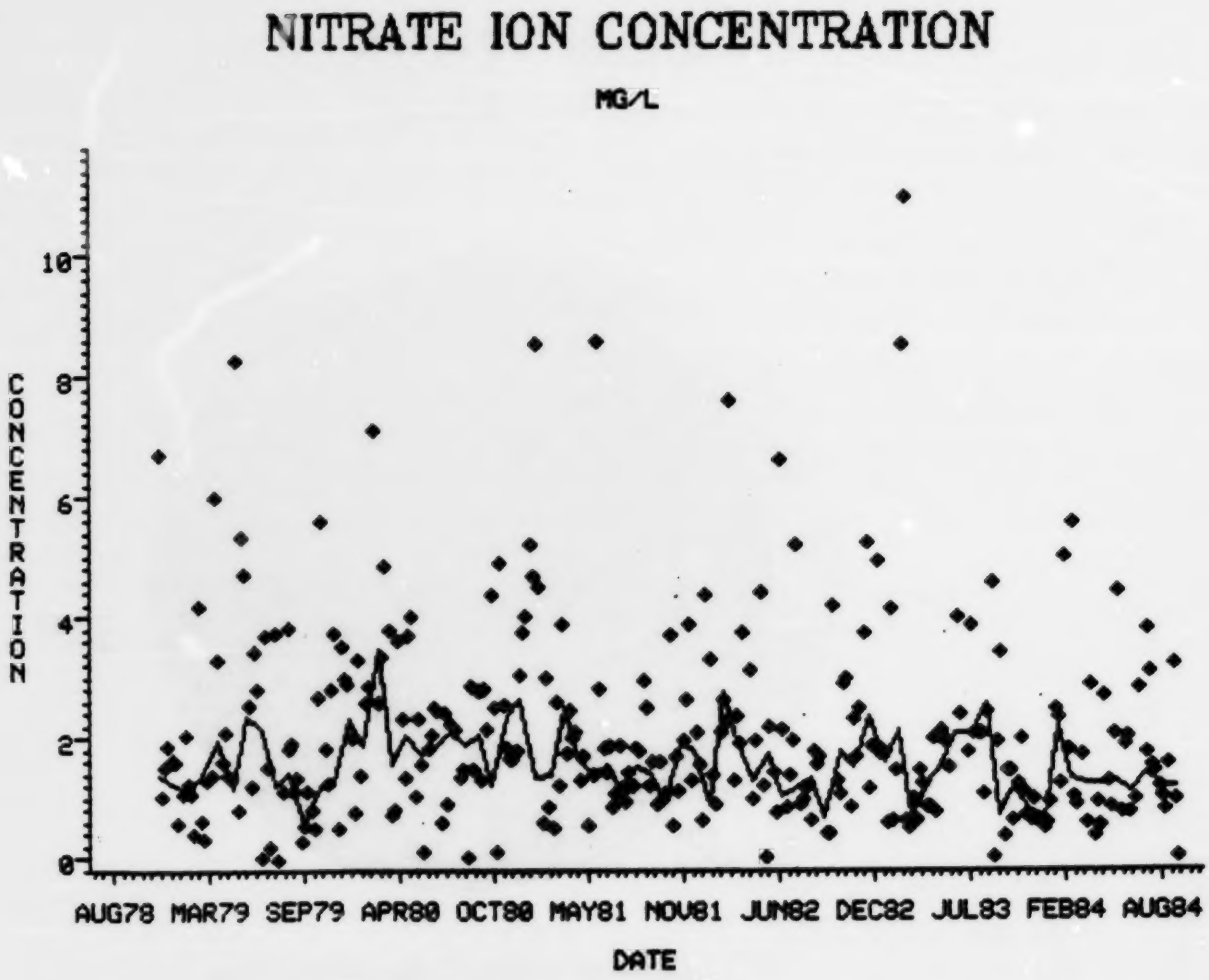


Figure 3. Symbols show nitrate ion concentration (mg/l) in weekly precipitation samples at Huntington Wildlife Forest, Nov. 1978-Oct. 1984. The volume-weighted mean monthly nitrate ion concentration is plotted through the sample points.

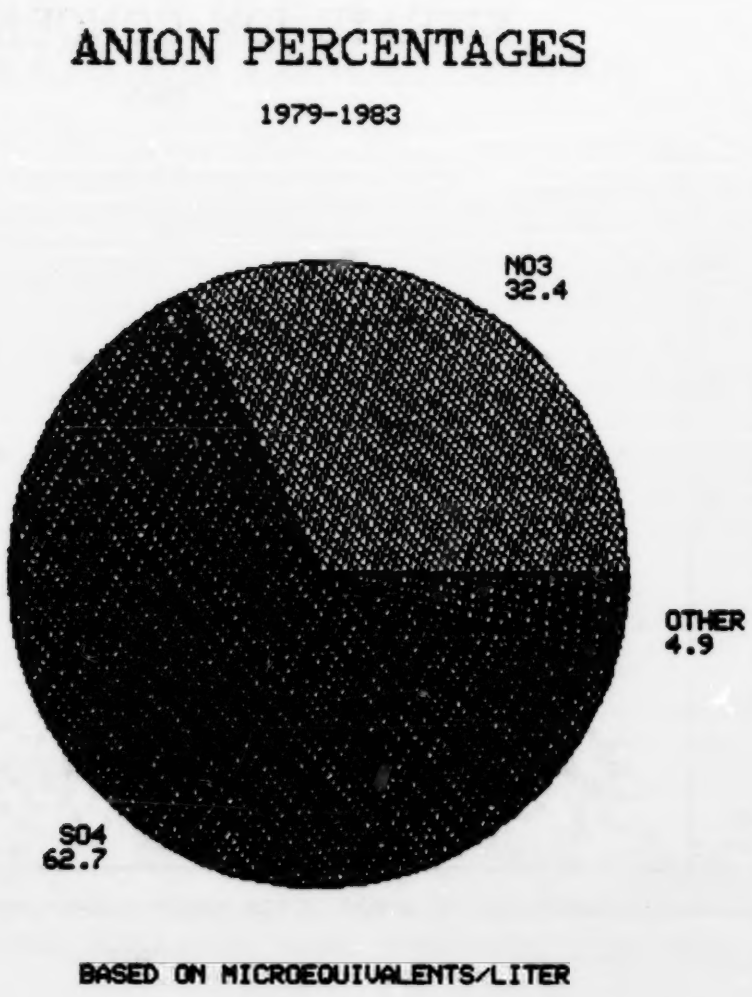


Figure 4. Anion percentages in wet deposition at Huntington Wildlife Forest, Nov. 1978-Oct. 1984.

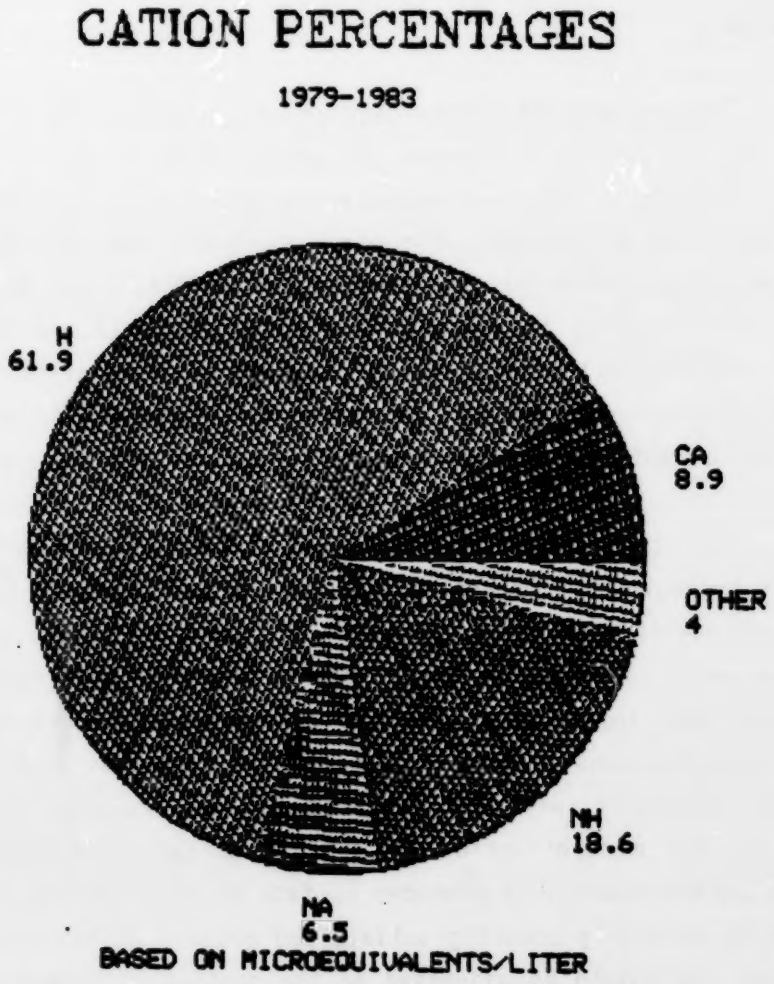


Figure 5. Cation percentages in wet deposition at Huntington Wildlife Forest, Nov. 1978-Oct. 1984.

concentration than by precipitation patterns. The central Adirondack region receives about 30 kilograms per hectare per year of sulfate or about 27 pounds of sulfate per acre. Nitrate deposition amounts to about 20 kilograms per hectare per year or about 18 pounds per acre. Table 1 shows the deposition of ions at Huntington Forest over a several year period.

Forests are not simply passive recipients of ionic inputs, but rather the tree canopy influences the nature of ionic deposition dramatically. Figures 6 and 7 illustrate the pattern of ion movement from bulk precipitation through Adirondack hardwood and deciduous forest ecosystem strata based on the findings of Mollitor and Raynal (1982, 1983). Ions reaching the forest floor in throughfall are derived from several sources including dissolved substances from distant and local points, particles and aerosols deposited on vegetation or scavenged by precipitation and ions leached from foliage.

The two forest canopy types affect ion flux similarly, although hydrogen ion concentration was reduced beneath the hardwood canopy whereas it was little altered by the conifer canopy. Nitrate and potassium were conserved in these forests whereas leaching of calcium, magnesium, and sodium was observed as moisture passed through the mineral soil horizons. It is likely that the ions lost from the pool of ecosystem nutrients will be replaced by ion release from mineral weathering and mineralization of organic matter. Whether long-term input of anthropogenically produced sulfate to these forests accelerates leaching by naturally occuring sulfate and organic anions requires long-term study and should be addressed in the context of forest vegetation, soil, and hydrological characteristics of the ecosystems.

Table 1. Wet and dry deposition of ions (kg ha^{-1} yr^{-1}) and total yearly deposition (Σ) at Huntington Wildlife Forest, 1970-1981.

	1979			1980			1981		
Ion	Wet	Dry	Σ	Wet	Dry	Σ	Wet	Dry	Σ
Ca^{2+}	1.20	0.60	1.80	1.35	0.79	2.14	1.62	0.48	2.10
Mg^{2+}	0.25	0.13	0.38	0.25	1.17	0.42	0.42	0.14	0.56
K^{+}	0.22	0.45	0.67	0.40	0.50	0.90	0.21	0.27	0.48
Na^{+}	1.86	0.22	2.08	1.31	0.22	1.53	0.65	0.17	0.82
NH_4^{+}	1.71	0.79	2.50	3.59	2.15	5.74	2.48	1.18	3.66
H^{+}	0.50	0.03	0.53	0.51	0.01	0.52	0.43	0.04	0.47
NO_3^{-}	16.50	3.00	19.50	17.95	2.15	20.10	14.02	3.21	17.23
Cl^{-}	1.34	0.17	1.51	1.63	0.37	2.00	1.01	0.36	1.37
SO_4^{2-}	25.75	4.77	30.52	24.94	5.46	30.40	23.14	3.46	26.60
PO_4^{3-}	0.03	0.15	0.18	0.48	0.64	1.12	0.04	0.24	0.28

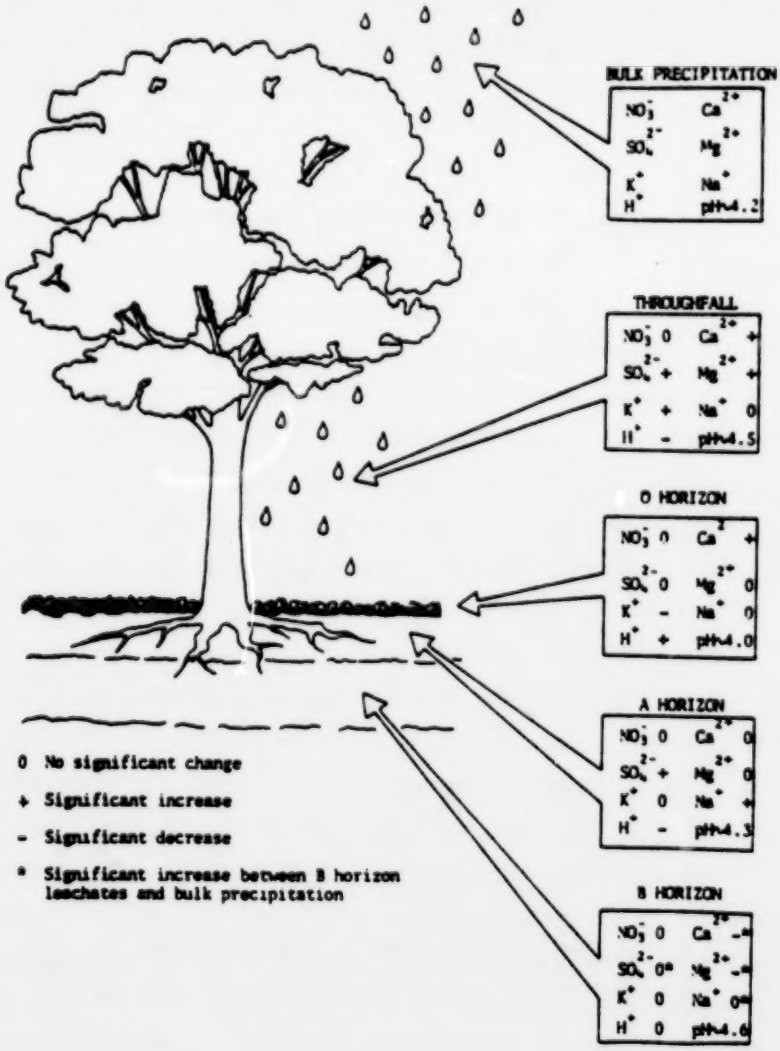


Figure 6. Pattern of ionic movement from the atmosphere (Bulk Precipitation), through the canopy (Throughfall), forest floor (O Horizon), and upper (A Horizon) and lower (B Horizon) mineral soil horizons in a hardwood forest at Huntington Wildlife Forest (after Mollitor and Raynal 1982, 1983). Legend refers to statistical analysis of original data ($P \leq 0.05$).

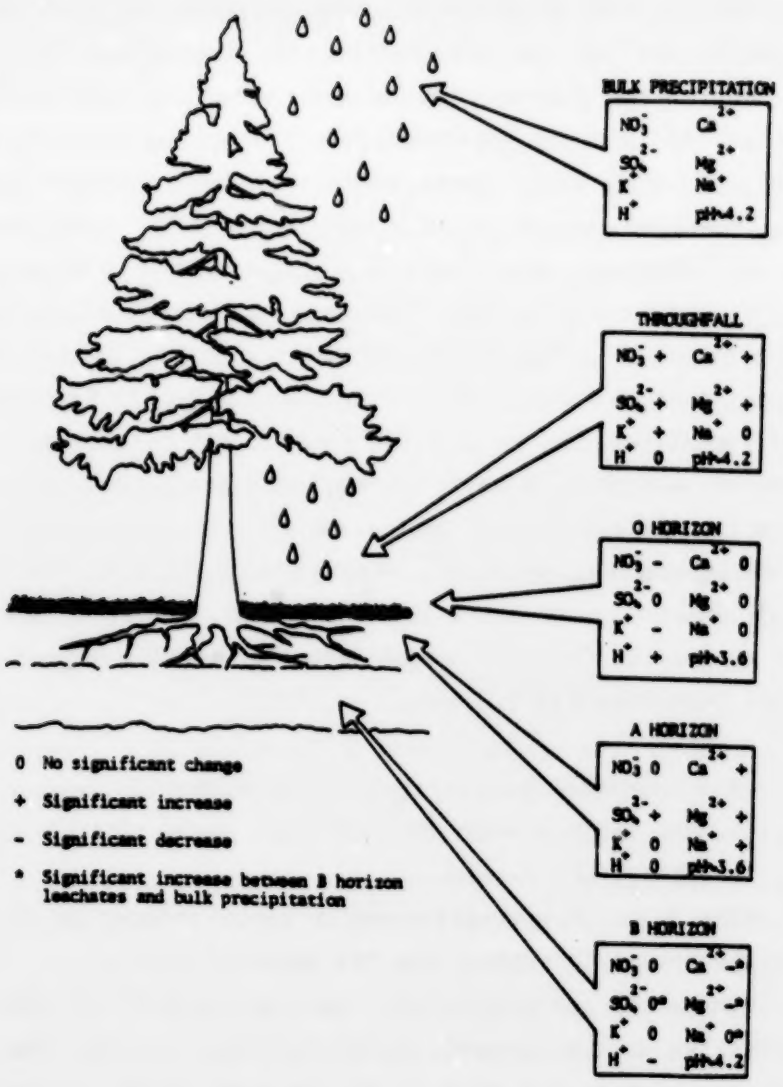


Figure 7. Pattern of ionic movement from the atmosphere (Bulk Precipitation), through the canopy (Throughfall), forest floor (O Horizon), and upper (A Horizon) and lower (B Horizon) mineral soil horizons in a conifer forest at Huntington Wildlife Forest (after Mollitor and Raynal 1982, 1983). Legend refers to statistical analysis of original data ($P \leq 0.05$).

Forest Decline

One of the most conspicuous examples of tree decline in eastern North America is the decline of red spruce (*Picea rubens* Sarg.). Needle death, crown thinning and dieback, growth reduction, and mortality of this species have been described by numerous investigators (McIntosh and Hurley 1964, Roman and Raynal 1980, Johnson and Siccama 1983a, b, Siccama et al. 1982, Vogelmann 1982, Tomlinson 1983). Symptoms typically include needle discoloration and subsequent death, thinning of foliage or crown branches, and eventual branch death. Symptoms progress from the upper and outer portions of the tree crown toward the inner and lower portions, culminating in mortality. The causes of red spruce decline are unknown but the disease well fits the definition of a tree decline: "a complex disease condition caused by the interaction of a number of biotic and abiotic factors that produce a gradual deterioration, typically ending in mortality" (Manion 1981). Decline of red spruce is not a new phenomenon, however. Consider the following quotations from The Annual Report of the New York State Forest Commission, 1894 (Fox 1894):

> "A noticeable peculiarity of the Adirondack spruce is the large number of defective trees scattered throughout the forest".
> "The great blight destroyed a large proportion of the spruce throughout the Adirondack Forest".
> "Competent authorities who had made a study of the matter on the ground, estimated that at one time one-third to one-half of the matured spruce in the Adirondack region was dead".

Clearly, red spruce decline episodes have occurred in the past. Whether acidic deposition represents a new causal agent in the dieback of this species is presently the focus of considerable scientific research.

Dendrochronological Studies

Tree rings embody historical records of tree growth characteristics and, as such, enable scientists to reconstruct the chronology of changing growth patterns. The science of tree ring analysis is known as dendrochronology. Because the relationship between tree ring measurements taken at breast height (1.4 m) and total wood volume may be highly variable, standard dendrochronological measurements may not give the best assessment of the growth characteristics (LeBlanc and Raynal 1985). Detailed stem analysis, in which growth increments are determined from disks cut from each internode along the bole of tree, can provide a sensitive dendroecological assessment of tree growth-environment relationships. Figure 8 shows profiles of annual growth layers for a representative Norway spruce (Picea abies Karst.) which grew in a plantation on sandy glacial outwash in the southeastern Adirondack Mountains (LeBlanc 1985). Growth during early years after establishment was rather uniform and normal but in the mid 1960's, a dramatic decline in growth occurred, which, after a 1970's recovery, is evident again in the late 1970's and early 1980's. Similarly, inspection of Figure 9A, which shows mean ring width of 2 groups of Norway spruce, based on measurements along the entire tree bole, reveals a clear growth reduction in the mid 1960's and late 1970's. To interpret these changes in tree growth, climatic data are used in a multiple regression analysis (Fritts 1976) to determine the amount of variability in growth that is explained by the prevailing climatic conditions. Figure 9B depicts the residuals from the regression model and indicates the degree to which growth in any period is influenced by climate variables. The plot, which fluctuates above and below the zero value without following a long-term negative trend, illustrates that climate, in fact, explains much growth variation. There is no progressive long-term downward trend that can be associated with acidic deposition. However, there are many points (years) along the residual plot that indicate that growth decline is not well correlated with climate conditions. A single causal agent such as acidic deposition as an overriding influence may rarely result

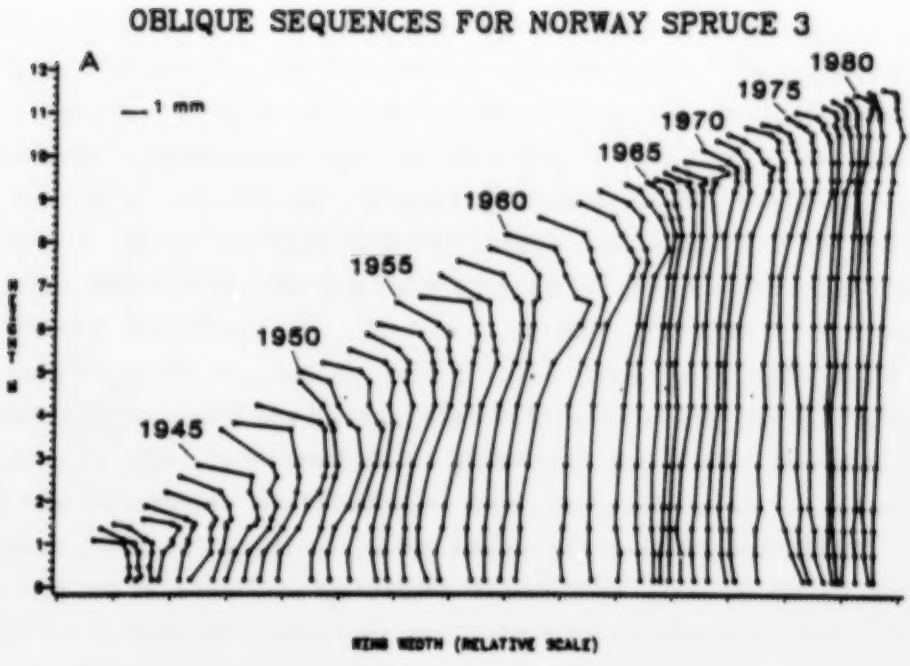


Figure 8. Oblique sequence chronoseries of a representative Norway spruce tree at Pack Experimental Forest.

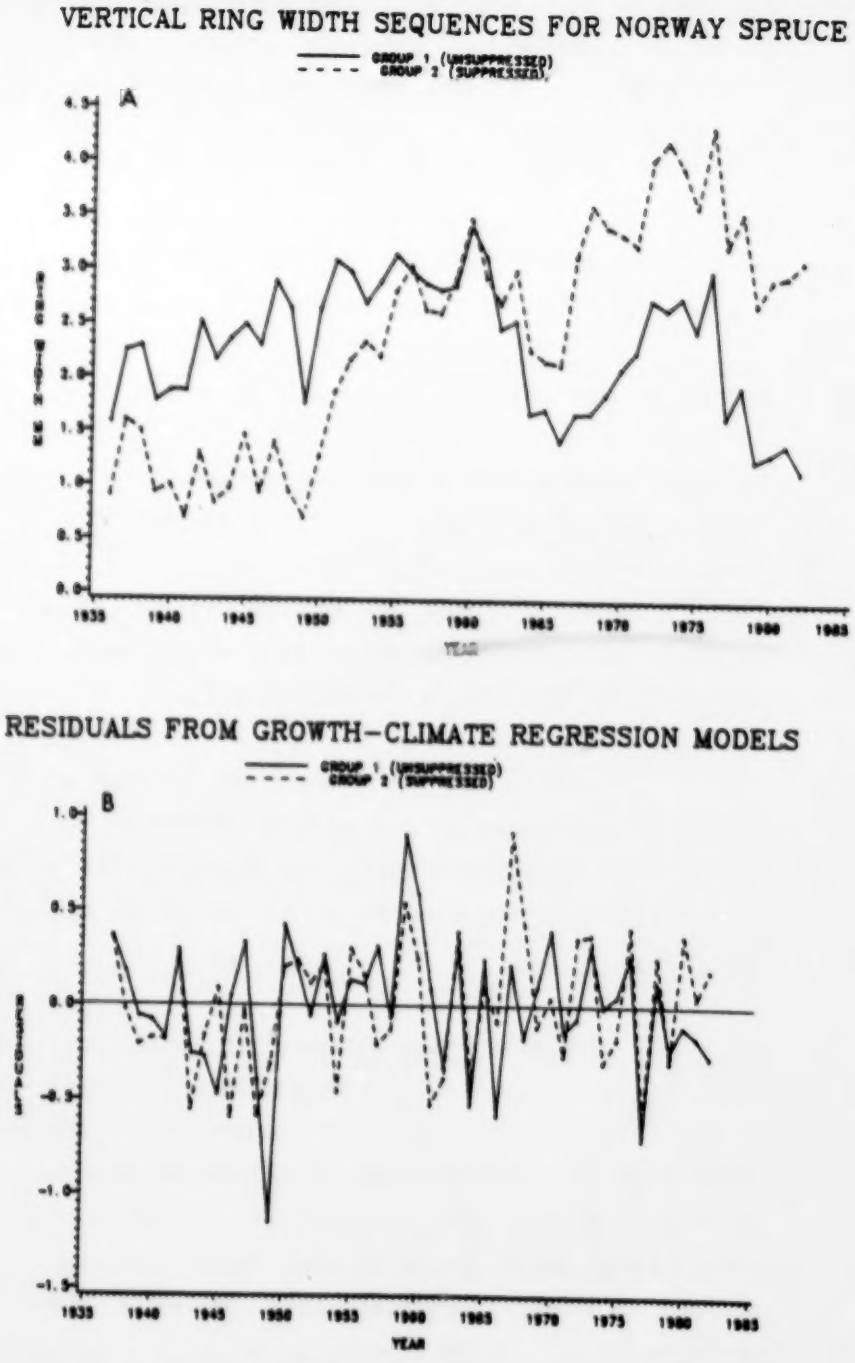


Figure 9. A. Vertical sequence mean ring width for 2 groups of Norway spruce at Pack Experimental Forest.
B. Residuals for growth-climate models for Norway spruce sample trees shown in A.

in decline episodes, but as a contributory factor, acidic deposition along with naturally occurring stress such as drought, temperature extremes, disease pathogens and insects, may produce tree growth decline.

Detailed stem analysis is currently being used to determine historical growth patterns in red spruce in mountain forests and to evaluate the role of acidic deposition in decline of this species.

Conclusions

Atmospheric deposition measured at Huntington Wildlife Forest in the central Adirondack Mountains of New York indicates that precipitation pH there (volume-weighted annual mean of 4.5) is comparable to that recorded throughout New England, eastern Canada and the upper Great Lakes area. Deposition of sulfate and nitrate ions measures about 30 kg/ha/yr and 20 kg/ha/yr respectively.

Patterns of ionic movement in hardwood and conifer forest ecosystems were similar but concentrations of ions in various strata in the coniferous systems generally exceeded that in the hardwood system. Cation leaching was apparently influenced by sulfate and organic anion leaching.

Many scientists assume that atmospheric deposition as well as biological and physical stresses interact in a very complex way to affect forest vitality. Conclusive cause and effect relationships between acidic deposition and tree decline have not yet been demonstrated. The relationships, however, will undoubtedly be clarified in the near future as scientists, with research support from government and private agencies, investigate this complex problem.

REFERENCES

Fox, W. F. 1895. **The Adirondack black spruce,** The Forest Commission, State of New York, Albany, N.Y.

Fritts, H. C. 1976. **The rings and climate,** Academic Press, New York, N.Y.

Johnson, A. H. and T. G. Siccama. 1983a. "Acid deposition and forest decline", **Environ. Sci. Tech.** 17:294-306.

Johnson, A. H. and T. G. Siccama. 1983b. **Spruce decline in the northern Appalachians: evaluating acid deposition as a possible cause,** Proceedings of the Annual Meeting of the Tech. Assn. of the Pulp and Paper Industry. pp. 301-310.

LeBlanc, D. C. 1985. **The use of stem analysis to assess effects of acidic deposition on coniferous tree growth,** Ph. D. thesis. SUNY College of Environmental Science and Forestry, Syracuse, N.Y. 290 pp.

LeBlanc, D. C. and D. J. Raynal. 1985. **Dendroecological analysis of acidic deposition effects on forest productivity,** NATO Advanced Workshop on Acidic Deposition Effects. Springer-Verlag. In press.

Manion, P. D. 1981. **Tree disease concepts,** Prentice Hall Inc., Inglewood Cliffs, N.Y. 399 pp.

McIntosh, R. P. and R. T. Hurley. 1964. "The spruce fir forests of the Catskill Mountains", **Ecology** 45: 314-326.

Mollitor, A. V. and D. J. Raynal. 1983. "Atmospheric deposition and ionic input in Adirondack forests", **J. Air Pollution Control Assoc.** 33:1032-1035.

Mollitor, A. V. and D. J. Raynal. 1982. "Acid precipitation and ionic movement in Adirondack Forest Soils", **Soil Sci. Soc. America Journal** 46:137-141.

Roman, J. R. and D. J. Raynal. 1980. **Acid precipitation on vegetation,** p. 4-1 to 4-63, In Raynal, D. J., A. L. Leaf, P. D. Manion, and C. J. K. Wang (eds.) Actual and potential effects of acid precipitation on a forest ecosystem in the Adirondack Mountains, NYSERDA Publ. No. 80-28.

Siccama, T. G., M. Bliss and H. W. Volgelmann. 1982. "Decline of red spruce in the Green Mountains of Vermont", **Bull. Torrey Bot. Club** 109:163-168.

Tomlinson, G. H. 1983. **Die-back of red spruce, acid deposition, and changes in soil nutrient status - a review,** In B. Ulrich and J. Pankrath (eds.) Effects of Accumulation of Air Pollutants in Forest Ecosystems, D. Reidel Publ. Co., Boston, MA.

Vogelmann, H. W. 1982. "Catastrophe on Camel's Hump", Natural History 91:8-14.

BIOGRAPHY

Dr. Raynal is a professor at the Department of Environmental and Forestry Biology, State University of New York, Syracuse, since 1974.

Dr. Raynal received his Bachelor's Degree in science at Clemson University of South Carolina in 1969 and his Ph.D. in plant ecology at the University of Illinois.

In 1982 he was a visiting scientist at Sheffield University, England. His fields of study are vegetal populations and the ecology of communities, demography and the life cycle of plants, and the effects of atmospheric depositions on forest ecosystems.

Dr. Raynal is a member of the American Association for the Advancement of Science, the Botanical Society of America, the British Ecological Society and the Ecological Society of America. He is the author and co-author of many publications.

LE DÉPÉRISSEMENT DES ÉRABLIÈRES AU QUÉBEC: PROBLÉMATIQUE ET ÉTAT DES RECHERCHES

Lise Robitaille
Ingénieur forestier, M.Sc.F
Direction de la recherche forestière
Ministère de l'Énergie et des Ressources du Québec

ABSTRACT

Outline of the problem

The phenomenon of maple dieback was noticed in Québec at the beginning of the 1980's by sugar bush owners in Beauce. The problem spread in the summer of 1982, becoming more severe and affecting a wider area including Mégantic, Frontenac and Arthabaska counties. An aerial survey of an area of 19,400 km^2 in the most affected zone indicates that only 16.6 percent of the maple stands covered showed no trace of dieback. Other cases have also been found, particularly in counties adjacent to the above.

In Ontario, scientists have studied maple stands and found an unusually high rate of dieback in the sugar maple and white ash.

Symptoms

The symptoms of this dieback are the appearance of smaller, paler leaves, slower growth rates and healing of tap holes, the gradual loss of leaves, starting around the crown which shrinks gradually until the tree dies, and loosening of the bark on the main branches and trunk.

Investigation

In the autumn of 1982, at the request of the Associate Deputy Minister of Forestry, researchers from the ministère de l'Énergie et des Ressources in co-operation with colleagues from the Laurentian Forest Research Centre of Agriculture Canada, Laval University and the ministère de l'Agriculture, des Pêcheries et de l'Alimentation proposed specific studies to determine the causes of this dieback and ways of combatting it or attenuating its effects.

The hypotheses advanced to account for this dieback can be summarized as follows: unfavourable climatic conditions; the forest tent caterpillar epidemic; the elimination of companion species such as the yellow birch and beech; vacuum sap collection; acid precipitation; atmospheric pollution; the effect of certain fungi; and some others.

Results

After two seasons of field work, the ministère de l'Énergie et des Ressources researchers observed that the most affected stands were located on summits - and therefore on thin, dry soil - and in wet depressions. Also, the growth rate studies indicate a decline of some 34.6 percent over the past five years compared to the rate some 10 or 20 years ago. In addition, chemical analysis of the soils disclosed acidification of the different horizons as well as various deficiencies in elements the trees can assimilate. These phenomena seem to have appeared in the past few years.

The researchers also reported that they can rule out some hypotheses as primary causes of the dieback. For instance, tapping and the various ways of doing it, as well as the elimination of companion species, cannot be retained, because the dieback is found in maple

groves for lumber production that have not been tapped. Moreover, dieback and abnormal mortality have been observed not only in sugar and red maple but also in yellow birch and beech.

As to the fungi found on the affected trees, they do not seem to be responsible for the dieback but come into play when the condition is already well advanced.

Current analyses indicate that climatic conditions such as the February 1981 thaw and the drought at the beginning of the summer of 1982, as well as the epidemic of forest tent caterpillars from 1980 to 1982, accelerated the dieback process, but that these factors are not the main causes. This leaves the acid precipitation problem as the suspect. Although they cannot prove it yet, the researchers think that acid precipitation may play a very important role in this dieback phenomenon, particularly because of the imbalance found in soil fertility. Moreover, the most affected region is the one that receives the greatest quantity of acid deposits - 40 kg per hectare per year.

It should also be pointed out that the dieback became more pronounced from 1983 to 1984 in the sample sites established in 1983.

LE DÉPÉRISSEMENT DES ÉRABLIÈRES AU QUÉBEC: PROBLÉMATIQUE ET ÉTAT DES RECHERCHES

Lise Robitaille
Ingénieur forestier, M.Sc.F
Ministère de l'Énergie et des Ressources du Québec

Messieurs les Ministres, messieurs les Gouverneurs, mesdames, messieurs, je vous remercie de m'avoir invitée à vous entretenir au nom de mes confrères de travail du problème de dépérissement des érablières du Québec.

Historique

Les premières inquiétudes manifestées par les producteurs de sirop d'érable remontent à l'automne 1978 lors de trois journées d'information organisées par le ministère de l'Agriculture du Québec. À cette époque, plusieurs producteurs nous firent part que des érables sèchaient sans raison apparente.

À l'automne 1980, un de nos confrères agronomes, monsieur François Gagnon, organisa une tournée dans quelques érablières de la Beauce et des comtés avoisinants où l'on observait des arbres, gros et petits, qui mouraient par groupes de huit à dix. Les propriétaires concernés disaient avoir remarqué ce phénomène depuis trois ans.

À l'été 1981, le phénomène s'accentua et à l'été 1982, le dépérissement se manifesta violemment sur une grande superficie, principalement dans les comtés de Beauce, Mégantic, Frontenac et Arthabaska.

À l'automne 1982, à la demande du sous-ministre associé aux Forêts, des chercheurs du ministère de l'Énergie et des Ressources du Québec, en collaboration avec des chercheurs du ministère de l'Agriculture du Canada, de l'Université Laval et du ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec, proposèrent une série d'études pour connaître les causes du dépérissement et pour découvrir des moyens de le combattre et d'en réduire les effets.

Symptômes

Le dépérissement est un phénomène insidieux qui risque d'être irréversible. Il faut un oeil averti pour déceler les arbres atteints qui sont au stade maladif. Chaque année, la forêt est moins belle mais on s'y habitue. On trouve normal que des arbres sèchent le long des chemins carrossables et autour de la cabane à sucre.

Il existe une différence entre les arbres qui meurent normalement et ceux qui meurent de dépérissement; ces derniers se caractérisent par les symptômes suivants:

- le déploiement de feuilles plus petites et plus pâles et qui ont tendance à se colorer plus tôt à l'automne; ces feuilles sont souvent chlorosées ou jaunies ou nécrosées ou brunies;

- le ralentissement de la vitesse de cicatrisation des entailles et du taux de croissance en diamètre; de plus, les branches tertiaires ne poussent presque plus;

- la perte graduelle de feuillage à partir du pourtour de la cime qui se rétrécit graduellement jusqu'à la mort de l'arbre;

- finalement, le décollement de l'écorce sur les branches maîtresses et sur le tronc. De plus, l'ouverture du couvert forestier provoquée par la perte du feuillage et la mort des arbres favorise le développement et la croissance des espèces herbacées, arbustives et arborescentes qui forment le sous-bois.

Hypothèses

Au départ, nous avons identifié trois catégories de causes pouvant affecter les érables: les causes permanentes avec effets à long terme telles que la coupe des essences compagnes, le vieillissement, l'entaillage, le pâturage par les animaux, la pollution de l'air et du sol; des causes accidentelles avec effets à court terme telles que le climat et les épidémies d'insectes; et des causes accessoires telles que le champignon armillaire.

Relevés aériens

Pour donner suite aux nombreux cas dits de "dépérissement" de l'érable à sucre rapportés en 1982, le Service d'entomologie et de pathologie du ministère de l'Énergie et des Ressources a effectué, au cours des étés 1983 et 1984, des relevés aériens pour évaluer les dommages dans la zone jugée la plus affectée. L'objectif de ces relevés aériens était de préciser le lieu et de quantifier, dans la mesure du possible, le niveau de dépérissement des peuplements d'érables.

Les relevés aériens ont couvert une superficie de 19 400 kilomètres carrés, limitée au nord par le fleuve Saint-Laurent et au sud par la frontière américaine. À l'est, la superficie couverte s'arrêtait à Montmagny et, à l'ouest, à Victoriaville. Trois hélicoptères ont été utilisés pour effectuer ce travail qui a nécessité environ 100 heures de

vol. Le survol du territoire a commencé à l'été 1983, du 23 au 31 août, pour se poursuivre à l'été 1984, du 22 au 23 août. L'aéroport de Québec a servi de base d'opérations pour l'ensemble du territoire.

On voit ici du dépérissement. Toutes les cimes qui sont grises sont celles d'arbres ayant des problèmes. Les arbres blanchis sont complètement séchés. Et puis on voit des teintes jaunes dans le feuillage; ce sont des arbres qui sont en train de dépérir, qui sont sous stress. Si on se rapproche, on voit que ces arbres-là qui étaient en santé sont en train de mourir.

La méthode de travail utilisée pour faire le relevé des peuplements consistait à suivre des lignes de vol parallèles, à tous les deux kilomètres, en direction nord-sud. Ces lignes de vol avaient été préalablement tracées sur des cartes topographiques à grande échelle 1:50 000. À bord de l'hélicoptère, l'observateur traçait le contour des peuplements d'érables survolés et notait, sur ces cartes, ses observations concernant la classe de dépérissement. Ces observations furent ensuite transcrites sur des cartes à l'échelle 1:50 000 avant d'être réduites à l'échelle 1:250 000. On a ainsi obtenu une image globale du dépérissement dans la région survolée.

L'évaluation du niveau de dépérissement est basée sur la proportion moyenne de feuillage manquant dans la cime des arbres. Le tableau 1 présente la classification des superficies observées lors des relevés aériens de 1983 et 1984. Nous remarquons que le taux de dépérissement est léger, modéré ou élevé, sur 29 pour cent de la superficie des peuplements d'érables observée. Par ailleurs, seulement 16,6 pour cent des superficies survolées ont été jugées saines. On peut donc conclure que plus de 83 pour cent des érablières sont affectées par le dépérissement. Cependant, on remarque dans la colonne de 1984, que seulement 0,8 pour cent des peuplements étaient sains, comparativement à

Tableau 1. Classification des superficies observées lors des relevés aériens de 1983 et 1984

Année	1983		1984		1983 et 1984	
Classe de dépérissement*	Superficie observée (km^2)	Pourcentage	Superficie observée (km^2)	Pourcentage	Superficie observée (km^2)	Pourcentage
Sain	322	33,9	8	0,8	330	16,6
Trace (1-10 pour cent)	302	31,8	777	75,1	1 079	54,4
Léger (11-25 pour cent)	242	25,5	209	20,2	451	22,8
Modéré (26-50 pour cent)	77	8,1	33	3,2	110	5,5
Élevé (51 pour cent et plus)	7	0,7	7	0,7	14	0,7
Superficie totale des peuplements d'érable observés (km^2)	950	100,0	1 034	100,0	1 984	100,0
Superficie totale survolée (km^2)	14 000		5400		19 500	

* L'évaluation du niveau de dépérissement est basée sur le pourcentage moyen de feuillage manquant dans la cime des arbres.

34 pour cent dans l'inventaire de l'année précédente, en 1983. Le phénomène a donc évolué; vous allez d'ailleurs le constater sur la carte.

Envergure du problème

Notre recherche ne touche pas seulement les érablières aménagées pour la production de sirop d'érable, mais l'ensemble de la forêt du sud du Québec. En effet, on a observé du dépérissement et une mortalité anormale, non seulement chez l'érable à sucre et l'érable rouge, mais aussi chez le bouleau jaune et le hêtre et même dans des peuplements composés de diverses essences et destinés à l'approvisionnement de l'industrie forestière. Tout porte à croire que les peuplements mélangés et résineux seraient aussi affectés.

La semaine dernière, je suis allée à Toronto rencontrer des chercheurs. Je tiens à vous souligner qu'ils ont les mêmes problèmes, les mêmes symptômes qu'au Québec, qu'ils ont un peu de dépérissement sur une bonne partie de leur territoire et que les essences affectées sont l'érable à sucre, le frêne blanc, le hêtre et les bouleaux. Ils ont même observé du dépérissement chez le pin blanc.

Dispositif expérimental

Au cours des étés 1983 et 1984, nous avons établi et étudié 129 places d'étude semi-permanentes. Ces places nous ont permis d'échantillonner 7000 arbres.

On appelle érablière tout peuplement qui comporte 50 pour cent et plus d'érables à sucre. Il n'existe pas de peuplement pur d'érables à sucre à l'état naturel. Ceux-ci résultent de l'action de l'homme qui a coupé les essences compagnes. Il existe différentes sortes d'éra-

blières dont le potentiel varie selon l'épaisseur du sol, le drainage, l'altitude, l'exposition et le climat. Nous avons basé notre étude en classifiant les différentes érablières selon leur milieu, riche ou pauvre, puis en les regroupant en huit associations ou sous-associations.

Vous avez ici le schéma d'une sère physiographique représentant un flanc de montagne. Sur ce flanc de montagne, qui est typique du sud du Québec, on retrouve quatre types différents d'érablières. Vous avez, au sommet, l'érablière à bouleau jaune et hêtre. Le hêtre accompagne surtout l'érable à sucre. Les sols sont minces et pauvres, le drainage est sec. Sur ces sols, les peuplements sont très affectés par le dépérissement.

Au milieu de la montagne, on retrouve l'érablière à bouleau jaune typique. L'érable à sucre est surtout accompagné du bouleau jaune. Le sol est moyennement riche. Le drainage est assez bon. Le dépérissement est moyen à cet endroit.

Je tiens à souligner que ces deux premiers groupements, celui du sommet et du milieu de la montagne, sont les plus largement représentés dans la région étudiée.

Si on descend un peu plus bas, on retrouve l'érablière à bouleau jaune et tilleul. Ce groupement croît sur des sols riches. Le drainage est bon et plusieurs essences de valeur accompagnent l'érable à sucre. Le taux de dépérissement est inférieur sur ces sols riches.

Finalement, au pied de la montagne, vous avez l'érablière à bouleau jaune et frêne noir. Ce groupement croît sur un sol riche, mais humide. Et c'est là qu'on observe le plus fort taux de dépérissement.

Les prochaines diapositives illustrent les groupements forestiers décrits précédemment. Vous avez ici un exemple d'un peuplement qui croît sur les sommets de montagnes, là où l'on retrouve des taux élevés de dépérissement. Dans le présent cas, le taux de dépérissement est d'environ 70 pour cent. Le propriétaire a coupé les arbres.

Sur la diapositive suivante, on retrouve une forêt plus âgée sur un sommet de montagne; on remarque que le feuillage est petit, pâle et clairsemé alors que normalement, dans ce genre de forêt, les feuilles sont vert foncé, grandes et qu'il fait très sombre en sous-bois.

Cette autre diapositive illustre un peuplement situé au milieu de la montagne où le taux de dépérissement est moyen.

Enfin, vous avez des peuplements de bas de pente sur un site humide. C'est là que l'on retrouve le plus fort taux de dépérissement.

Sur la dernière diapositive, on retrouve une érablière riche, sur un sol profond. Ces types de peuplements n'ont pratiquement pas de problème, peut-être un taux de dépérissement de 0 à 5 pour cent.

Dans l'ensemble, tous ces peuplements que je viens de vous montrer étaient en excellente santé il y a cinq ans.

Étude de croissance

Lorsqu'un peuplement est malade, sa croissance n'est pas aussi rapide. Ceci occasionne une perte de matière ligneuse et aussi de sucre. La diminution de croissance pour les peuplements étudiés depuis les cinq dernières années est de 34,6 pour cent.

De plus, lorsque la croissance d'un arbre est faible, les blessures guérissent difficilement. Nous avons observé que dans les peuplements atteints de dépérissement, la cicatrisation des entailles est beaucoup plus lente depuis les cinq dernières années.

Étude des sols

Dans chacune des 129 places d'étude, nous avons creusé un profil de sol et procédé à des analyses chimiques de tous les horizons. Il existe une relation directe avec la quantité d'éléments dans le sol d'un groupement donné et son taux de dépérissement. Les érablières à tilleul, les plus riches, qui sont les moins affectées sont relativement mieux pourvues en éléments nutritifs. Une exception à la règle: l'érablière à bouleau jaune et frêne noir située sur des sites humides.

À la suite de l'observation globale des résultats des analyses de sol, il nous apparaissait qu'en général, pour les mêmes groupements forestiers et pour les sols de même texture, le pH des différents horizons avait sensiblement diminué, c'est-à-dire que ces sols sont plus acides. Certains cations échangeables ou éléments immédiatement disponibles pour la plante, comme le calcium, le magnésium et le potassium, avaient également diminué. De plus, plusieurs des sols que nous avons classés comme brunisols sur le terrain, c'est-à-dire comme sols riches de forêts feuillues, en raison de leur morphologie, ont été ramenés à l'ordre des podzols, ou sols plus pauvres, à la suite des analyses chimiques en laboratoire. Nous avons voulu pousser plus loin cette observation. Nous cherchions des preuves. Nous cherchions des témoins. Nous n'avons pas trouvé de peuplements où il n'y avait pas de dépérissement malgré nos recherches.

À l'automne 1984, nous avons échantillonné des profils de sol dans des peuplements qui avaient déjà été échantillonnés il y a dix et quinze ans. Nous avons retrouvé ces endroits et échantillonné de nouveau des profils de sol. Nous avons été surpris des résultats prove-

nant de trois endroits différents. Nous avons échantillonné treize profils au mont Mégantic situé au sud du Québec, quatre à Dudswell dans l'Estrie et quatre à la Station forestière de Duchesnay au nord de la ville de Québec. Dans tous les profils, il y a une constante: on remarque dans tous les horizons une baisse importante des cations échangeables ou des éléments immédiatement disponibles pour la plante.

Je vais vous donner un exemple. Prenons l'humus ou horizon de surface du profil de sol F3 échantillonné à Duchesnay à l'automne 1984; le calcium échangeable est passé de 6,3 m.é./100 g. en 1974 à 1,7 m.é./ 100 g. en 1984.

On a aussi remarqué une augmentation de l'acidité dans plusieurs profils de sol ainsi qu'une augmentation du rapport carbone/ azote (C/N), ce qui indique une diminution de la vitesse de minéralisation de la matière organique ou de l'activité des micro-organismes dans le premier horizon du sol. Pour nous, ceci est très inquiétant parce qu'il faut des centaines d'années pour qu'un sol se bâtisse. Un sol ne peut être modifié comme ça sur une période de dix ou quinze ans. De plus, à la Station forestière de Duchesnay, il n'y a pas eu d'épidémie d'insectes et on a observé du dépérissement.

On peut qualifier d'alarmantes ces observations venant de cette étude comparative. Nous ne pouvons nous empêcher de nous demander si les sols qui supportent les groupements résineux manifestent un appauvrissement comparable. Bien que nous n'ayons pas identifié clairement de dépérissement dans les groupements résineux, les attaques répétées de la tordeuse des bourgeons de l'épinette sont peut-être un signe d'affaiblissement des forêts et, de plus, les dégâts causés par cet insecte peuvent peut-être masquer les symptômes de dépérissement chez les résineux.

Il n'est pas toujours facile de mettre en évidence les causes de cette dégradation générale des sols. Cependant, étant donné l'état général des sols, on doit s'arrêter sur une ou des causes qui couvrent une grande partie du territoire. Ainsi, nous sommes arrivés à soupçonner fortement les précipitations acides et la pollution atmosphérique comme causes principales de cette perturbation des sols forestiers et par conséquent du dépérissement des érablières. D'autant plus que nous savons, grâce au réseau collecteur de précipitations acides du ministère de l'Environnement du Québec, que la région présentement sous étude est celle qui reçoit la plus grande quantité de dépôts acides, soit 40 kilogrammes par hectare par année, c'est-à-dire deux fois plus que le niveau jugé acceptable.

Si les précipitations acides et la pollution atmosphérique sont les principales causes du dépérissement des érablières, c'est dans cette direction que nous devrons orienter les recherches afin de déterminer des moyens pour combattre ou pour diminuer les effets de ces polluants.

Conclusion

Au Québec, le dépérissement des forêts feuillues est un problème bien réel. Le relevé aérien en démontre l'importance. Ce phénomène ne touche pas seulement l'érable, mais d'autres essences feuillues telles que le bouleau jaune, le hêtre, le frêne. Il touche des arbres de tout âge, jeunes et vieux, sains et malades.

Au Québec, les premières manifestations importantes du dépérissement remontent à l'été 1981, période où les forêts allemandes commençaient à mourir de façon anormale. Le phénomène continue de s'amplifier. Il touche surtout les groupements qui croissent sur les sommets de montagnes, sur les sols minces et secs, de même que ceux que l'on retrouve dans les dépressions humides. Le taux de croissance en diamètre a ralenti de 34,6 pour cent depuis les cinq dernières années

dans les peuplements étudiés. De plus, l'analyse chimique indique une acidification et un appauvrissement des sols.

Nous sommes désormais en mesure d'éliminer certaines hypothèses envisagées comme causes principales du dépérissement. Ainsi, les différentes méthodes d'entaillage et l'élimination des essences compagnes ne peuvent être retenues puisqu'on retrouve du dépérissement dans des érablières qui n'ont jamais été entaillées et qui sont destinées à la production de bois de sciage. Quant aux champignons présents sur les arbres affectés, on croit qu'ils ne sont pas responsables du dépérissement et qu'ils n'entrent en action que lorsque l'arbre est déjà fortement atteint.

À l'heure actuelle, les analyses tendent à démontrer que les conditions climatiques, de même que l'épidémie de livrée des forêts qui a sévi de 1980 à 1982, ont pu accélérer le processus de dépérissement, sans en être les causes premières. Reste à envisager le problème des précipitations acides. En raison surtout du déséquilibre observé dans la fertilité des sols, on estime que les précipitations acides pourraient jouer un rôle important dans le phénomène du dépérissement. Cette thèse, qui reste encore à démontrer, est étayée par le fait que la région la plus affectée est aussi celle qui reçoit la plus grande quantité de dépôts acides (40 kg/hectare/an).

Signalons enfin que, de 1983 à 1984, le dépérissement s'est accentué dans les places-échantillons établies en 1983.

Études à poursuivre

Le ministère de l'Énergie et des Ressources prévoit réévaluer au cours de l'été 1985, le taux de dépérissement dans les places d'études déjà établies. Nous allons aussi mettre l'accent sur l'échantillonnage de profils de sol qui ont déjà été échantillonnés il y a 10 ans. Cette dernière étude sera faite non seulement dans les érablières

mais aussi dans des groupements résineux et elle sera accompagnée d'une étude de croissance. On prévoit échantillonner au moins 100 profils de sol supplémentaires pour obtenir plus de preuves.

Cependant, ceci n'est pas suffisant. Comme l'ont dit récemment mes collègues de l'Ontario, le dépérissement des forêts qu'on observe actuellement est un phénomène qui n'a pas de frontière.

Les résultats que je viens de vous donner ne constituent qu'un premier déblayage. Il faut agir rapidement, car on est en train de perdre la forêt, les sols, une des sources les plus importantes d'oxygène pour la planète et un secteur économique de grande valeur.

Cependant, il n'est pas trop tard. Ceci me fait penser à une personne qui souffre d'allergie. Son organisme peut tolérer la substance qui lui est nocive pendant des années avant de manifester des symptômes au moment où elle atteint un point de saturation. Si on enlève la cause, la personne se sentira mieux, mais si on attend trop et que la personne fait de l'emphysème, on ne pourra plus rien pour la sauver. Il y a un point tournant, un point de non-retour, on ne l'a pas encore atteint, mais il faut se hâter.

Le Canada et les États-Unis ont à leur service d'excellents chercheurs scientifiques qui ont commencé à se pencher sur ce problème. Il serait souhaitable qu'ils puissent avoir les moyens nécessaires pour qu'au cours de l'été 1985, ils puissent établir un bon diagnostic et trouver des solutions pour remédier rapidement à ce problème.

De plus, il faudrait que les chercheurs travaillent en collaboration et qu'ils puissent échanger entre eux; car le dépérissement est dû à l'interaction de plusieurs facteurs et il vaut mieux comprendre l'écosystème forestier pour établir ce bon diagnostic.

BIOGRAPHIE

Lise Robitaille obtenait en 1968 un baccalauréat en sciences forestières de la Faculté de foresterie et de géodésie de l'université Laval. En 1970, elle obtenait sa maîtrise en sciences de la Faculté de foresterie et de géodésie de la même université. Depuis juillet 1970, elle occupe un poste au Service de la recherche du ministère de l'Énergie et des Ressources à titre de chargée de recherche en sylviculture des feuillus tolérants. Elle travaille en étroite collaboration avec la Station forestière de Duchesnay et elle est présidente d'un Comité de recherche multidisciplinaire en acériculture.

Lise Robitaille a de plus participé à plusieurs comités lors de l'élaboration des plans de gestion de la forêt publique. Depuis l'automne 1982, elle travaille intensivement sur le problème de dépérissement dans les érablières. Elle est présidente du Comité d'acériculture du Conseil des productions végétales du Québec qui relève du ministère de l'Agriculture, des Pêcheries et de l'Alimentation.

THE EFFECTS OF INHALED ACID ON HUMAN HEALTH

Dr. Morton Lippmann
Medical Center
New York University

RÉSUMÉ

L'inhalation d'aérosols acides ambiants a des répercussions sur la santé humaine et il existe quelques preuves suggérant que le nombre actuel d'expositions à ces aérosols en Amérique du Nord est à l'origine d'une hausse démesurée de la morbidité respiratoire. Les taux de mortalité moyenne annuelle ont été corrélés aux indices de concentration d'aérosols ambiants et, en tant que coefficients de prédiction, les sulfates, les particules fines, les particules inhalables et le total des particules en suspension dénotent un ordre décroissant. En plus, ces indices de pollution contiennent des ions H^+ dont le rapport masse est décroissant. Ils peuvent aussi se substituer aux ions H^+ comme agent actif. Des expériences dirigées, menées sur des humains et des animaux, montrent que les aérosols acides produisent des changements plus importants dans les mécanismes respiratoires et les taux de clairance (clearance) pulmonaire que tout autre constituant de matière particulaire ambiante.

La forte teneur en acide des aérosols ambiants n'a fait l'objet d'aucune mesure lors des études sur les effets des polluants sur la population. Aussi, l'absence de données immédiates sur les aérosols acides, auxquelles ont été substitués des indices comme l'anhydride sulfureux et les sulfates, ne permet pas de tirer de conclusions précises sur les relations exposition-réponse. Conséquemment, les recherches futures devraient porter sur les priorités suivantes: a) étude systématique de la distribution spatio-temporelle des populations exposées, b) prolongement et raffinement des études sur la réaction des populations à l'exposition

d'aérosols acides, c) réactions de volontaires asthmatiques et en santé aux mélanges d'aérosols acides et de vapeurs oxydantes dans des conditions déterminées d'exposition et d'exercice et d) progression des modifications dans l'épithélium des poumons d'animaux de laboratoire au cours d'expositions quotidiennes et répétées à des aérosols acides, des oxydants et leurs mélanges suivies de mesures sur la clairance (clearance) pulmonaire et les fonctions respiratoires.

THE EFFECTS OF INHALED ACID ON HUMAN HEALTH

Dr. Morton Lippmann
Medical Center
New York University

I appreciate the opportunity to talk to you about direct health effects of acid in the air. I will not discuss the health effects of acidic precipitation, but rather the effects of inhaling airborne strong acid aerosol. The evidence for adverse health effects at current North American exposure levels is not by any means conclusive, primarily because we have very poor and minimal data on acid exposures. We have extensive measurements of the precursor sulfur dioxide. We also have a substantial body of measurements of ambient levels of sulfate. Most of the measured sulfate is generally ammonium sulfate, which is a relatively neutral end product of the reaction sequence which begins when SO_2 is oxidized in the atmosphere to sulfuric acid, the most biologically active compound in the sequence. While still in the atmosphere, the sulfuric acid can be neutralized by ambient ammonia to ammonium sulfate.

The measured sulfate concentrations represent the summation of sulfuric acid, ammonium bi-sulfate (still a strong acid) and the nearly neutral ammonium sulfate. In the absence of exposure data for sulfuric acid, which is probably the causal agent for the health effects, we rely on sulfate ion as a surrogate.

Review of health effects associated with exposures to acidic aerosols

This review of the concern and evidence we have about inhaled acid and its effects on people begins with historic data from London

when air pollution killed people. In the famous December 1952 episode, the integral area under the daily mortality curve yielded an excess of about 4,000 deaths. This was associated with measurements made at that time. One was something called smoke (expressed in a quantitative mass concentration but in actuality a measurement of particle blackness not directly related to mass), and the other was sulfur dioxide (1). Any other pollutant measured at that time would, of course, have shown a similar accumulation in the fog.

After the fog lifted, the death rate did not come down as quickly as the pollutants because people who were weakened did not all die immediately. Some lingered a few days. The December 1952 episode was the most dramatic, but not the only episode of excess mortality. Periodically, London would have excess deaths due to something in the air. We will see later that acidic aerosol may very well have been the causal factor.

Analysis on the London experience shows that the excess mortality was more closely related to particles than to SO_2, and the smoke measurement could well have been a surrogate for an acid aerosol measurement.

Elevated pollution levels can not only cause excess mortality, but can also cause chronic health effects. In the same period, bronchitis, which could have resulted from regular or continuous exposure to airborne acid, was much higher in the U.K. than in Scandinavia. Within the U.K., it was much higher in more densely populated areas than in less densely populated areas, presumably because of the higher pollution levels in the more densely populated areas (1).

In the United States, a study by Dohan (2) in 1961 of women working for the RCA Corporation in five different cities found that lost days exceeding seven work days was associated with the mean suspended particulate sulfate concentration in their community.

Where does acid aerosol come from? A large part is attributable to the combustion of coal. When coal is burned, the sulfur is oxidized to sulfur dioxide, and the carbon to carbon dioxide, leaving a residual mineral particle of relatively large size. There is also a very fine aerosol, less than a tenth micrometre in diameter, formed by condensation of vapourized materials such as volatile trace metals. Within this ultrafine aerosol is a small fraction of the sulfur, as sulfuric acid aerosol. The large particle size ash in the effluent from a coal-fired power plant is easily caught in the clean-up device (a bag house, or an electrostatic precipitator). The ultra fine particles are not captured as efficiently, and even our best cleaned coal stacks are putting out a lot of ultrafine aerosols. While it is a vanishing small mass percentage of the fly ash, it may be the most active component.

Most of the sulfur is released as sulfur dioxide. Downwind ground surfaces remove SO_2 gas by dry deposition over a time scale of four days downwind, and a distance scale of a few hundred kilometres. From the time the SO_2 is released, it is gradually converted into sulfur trioxide, which rapidly hydrolizes and forms droplets of sulfuric acid. After about four days downwind or 1,000 kilometres downwind there is relatively little of the SO_2 gas remaining. The sulfuric acid aerosol is present in fine particles, is very persistent, and can travel many days beyond the source.

The best evidence we have for a direct causal relationship between sulfuric acid and health comes from Japan. A study actually done in the sixties was only reported last year by Kitagawa (3) in the

Journal of the Air Pollution Control Association. A pigment plant in Yokkaichi, Japan, was releasing sulfuric acid. Other pollutants were present but at relatively lower levels. With a point source of sulfuric acid and a geographically concentrated cluster of cases of respiratory morbidity downwind, there was a clear causal relationship, accounting for about 600 excess cases of respiratory morbidity during the 1960's. When, in 1968, an electrostatic precipitator was installed to collect the acid droplets, the cases stopped happening. The 1960's acid levels were higher than current North American ambient levels, but probably not higher than they were in London in the 1950's and 1960's. However, unlike London, there was less complication from other air pollutants, permitting a clear causal relationship between airborne acid aerosol and respiratory morbidity.

The next question then is whether there are any health effects due to airborne acid aerosols at current North American levels?

In Southern Ontario, Dr. Bates, from the University of British Columbia, has collected hospital admissions data for the 79 acute care hospitals covering the five million people in this region. There is uniform reporting of disease category in these hospitals, and he has taken the hospital admissions data and compared them to available data on ambient measurements of pollution.

In a Canadian Journal of Public Health paper published in 1983 (4) based on an analysis of correlations with sulfur dioxide, ozone, nitrogen dioxide, coefficient of haze (a very crude measurement of particles) and temperature, there were statistically significant associations between the respiratory hospital admissions and ozone and temperature. This suggests that ozone might be causing increased disease incidence.

More recently, Bates (5) reported on a multiple regression analysis in which he included sulfate, a pollutant index which he did not use in the earlier study. He was somewhat surprised to find that while sulfate data are of poorer quality, and are collected only every sixth day instead of every day, the sulfate data in the multiple regression analysis was a better predictor of hospital admissions than ozone. What could account for this finding? I have already indicated that sulfate includes sulfuric acid. The only active material in that pollutant mix called sulfate which could be producing these diseases is strong acid, i.e., sulfuric acid and ammonium bisulfate.

Bates also looked at other information. During this period, total admissions per day, in the summer, wer about 90 percent of those in the winter. Total admissions per day fell for both summer and winter during the period of study of about eight years, but respiratory admissions did not decline. In other words, although there was a downward trend in hospital admissions in this area, respiratory admissions did not decline, and asthma admissions rose during the same period.

There were no significant changes in the admission rate of control marker conditions, such as broken legs and other conditions not related to pollution.

What happened to the pollution during this period from 1974 to 1980? SO_2 in 1980 dropped to about 63 percent of the previous years' average. Ozone dropped to 87 percent of its previous rate, NO_2 dropped to 82 percent of its previous rate, the gross particulate measurement dropped to 90 percent of its previous rate. The only pollutant which was going up was sulfate, which went up to 111 percent of the previous level.

In the multiple regression analysis for asthma admissions, the sulfate accounted for about 12 percent of the variance in the data and was the most powerful indicator. Temperature, as expected, did have an influence on hospital admissions for respiratory disease. The ozone added very little to the multiple regression analysis variance.

Another study, done in Western Pennsylvania, also provides evidence that acid is affecting people at current North American levels. Schenker, et al (6) studied a population of about 5,000 non-smoking women living downwind of a cluster of mine-mouth coal-burning plants. The study also looked at a control population not downwind of these mine-mouth plants in the same area. They looked at the SO_2 and total particulate concentrations, but, unfortunately, that is all the pollutant data they had.

In terms of SO_2, one group of about 1,700 women had SO_2 exposures at about and slightly greater than our current U.S. standards for SO_2. Their particulate exposures were below our current standards in the United States.

In this population, one respiratory symptom, wheeze on most days or nights, was correlated with exposure to SO_2. Wheeze would not normally be seen in very many non-smoking women. There was a relative ratio going from 1.0 in the low exposed population to 1.4 in those exposed to an intermediate level of SO_2, and 1.95 (almost twice the incidence) in those at the highest exposure level. This shows that at current conditions, that are not much above current pollution standards in the U.S., we are seeing evidence of chronic disease in the lungs, and in particular, we see wheeze, which is characteristic of changes in the deep lung. However, SO_2 could not have been the causal factor since it is a highly water soluble gas which does not penetrate into the deep lung when it is inhaled.

What may account for the observed wheeze is that downwind of these stacks you have a fairly constant ratio of primary sulfuric acid formed as a condensation aerosol as the gas leaves the stack, and SO_2, and that the measured SO_2 was simply acting as a surrogate for another primary pollutant, sulfuric acid.

In Bates' Southern Ontario study, sulfuric acid was present as a secondary pollutant, one formed in the atmosphere. In the Pennsylvania study, it is probably primary sulfuric acid which was acting as the causal factor.

In a different kind of study, Ozkaynak and Spengler (7) at the NIEHS meeting on the health effects of acid rain at Research Triangle Park, NC, in November, reported on a study of annual mortality in 98 standard metropolitan districts in the United States. They studied whether the mean mortality correlated with available measurements of particulate pollution. They looked at: 1) total suspended particulate (TSP); 2) inhalable particulate (IP) (particulate less than 15 micrometres in aerodynamic diameter); 3) fine particulate (FP) (particles less than two and a half micrometres in size); and 4) sulfate. In general, all four of these indices were associated with mortality rates. In general, the particulate TSP and IP were not significantly associated with mortality. Fine particles and sulfate were significantly associated with the mortality rate. What we have is a progression of pollutant indices, with an increasing proportion of sulfuric acid. All of the sulfuric acid is in fine particles. All of the fine particles are within the inhalable particulate fraction, and all of the IP is included in TSP. If we have significant associations of health effects with crude indices like fine particulate and sulfate, I suspect we would have a greater coefficient and a more statistically significant effect if we could enter sulfuric acid concentrations into the correlations.

In laboratory tests with sulfuric acid we look for biological mechanisms, and evidence for responses in people. In terms of respiratory mechanics in exercising adolescent asthmatics, Koenig, et al. (8), at the University of Washington, Seattle found that 100 micrograms per cubic metre of sulfuric acid produced functional decrements.

In my own lab, we have studied the effects of sulfuric acid on the clearance of particles from the lung. In non-smoking healthy people we found that the clearance rate of particles deposited in the lung was accelerated by an hour's exposure to sulfuric acid at 100 micrograms per cubic metre. A one hour exposure at a concentration of 1,000 micrograms per cubic metre produces a slowing of clearance. These physiological changes last for a few hours (9).

In our animal work we found essentially the same transient responses. The studies were extended in the animals by giving them repetitive daily exposures. In six rabbits undergoing tests out to 52 weeks, clearance rates became and remained highly variable. At about eight months, we started to hear laboured breathing and we found significant changes in their airway conductance. Thus, single exposures produce the same physiological responses in humans and animals, and repeated exposures in animals produce a progression of changes which include markers characteristic of chronic bronchitis (10).

In earlier studies in our laboratory with cigarette smoke (11) the progression of effects was essentially the same. Two cigarettes produced an acceleration of clearance in humans and donkeys, while ten or fifteen cigarettes produced a transient slowing of clearance in donkeys. We know that cigarette smoking is a known causal factor in human chronic bronchitis. The sulfuric acid response may simply be a non-specific irritant response of an aerosol which affects the same deep part of the lung as cigarette smoke.

A number of years ago, my colleague, Dr. Roy E. Albert developed a schema for the effects of cigarette smoking on bronchitis, and I believe it also applies to sulfuric acid. Such irritants initially cause an acceleration of mucus production, and faster clearance. With further exposure, damage to the epithelial cells occurs, and after several weeks or months of repetitive daily exposure, clearance rates become highly irregular and mucus statis occurs, causing backup mechanisms such as cough to be invoked. Excess mucus accumulation leads to increased particle deposition and greater concentrations of irritants on the airways (12).

Summary and conclusions

In summary, I have provided a brief review of a lot of interrelated data. Only the Kitagawa study from Japan provides evidence for a causal relationship between human health effects and sulfuric acid. However, many other studies support the hypothesis that sulfuric acid affects people. Furthermore, the recent studies by Bates, et al in Canada and by Schenker, et al in Pennsylvania, which involve exposures that are much lower than those occurring in the historical London episodes, show that current exposure levels may be contributing to chronic disease.

REFERENCES

1. Beaver, H., Chairman. 1954. **Report of Committee on Air Pollution,** Cmd 9322, London, Her Majesty's Stationery Office.

2. Dohan, F.C. 1961. "Air pollutants and incidence of respiratory disease", **Arch. Environ. Health,** 3:387-395.

3. Kitagawa, T. 1984. "Cause analysis of the Yokkaichi asthma episode in Japan", **J. Air Poll. Control Assoc.** 34:743-746.

4. Bates, D.V. and R. Sizto. 1983. "Relationship between air pollutant levels and hospital admissions in Southern Ontario". **Can. J. Public Health,** 74:117-122.

5. Bates, D.V.. 1984. **Presentation at Int'l Epidemiol. Association Meeting,** Vancouver. B.C.

6. Schenker, M.B., F.E. Speizer, J.M. Samet, J. Gruhl and S. Batterman. 1983. "Health effects of air pollution due to coal combustion in the Chestnut Ridge region of Pennsylvania: Results of cross-sectional analysis in adults", **Arch. Environ. Health,** 38:325-330.

7. Ozkaynak, H. and J.D. Spengler. 1984. "Mortality and morbidity effects resulting from population exposures to airborne particles". Presented at NIEHS. Conference on Health Effects of Acid Precipitation, Nov. 15-16. Research Triangle Park, NC. **Env. Health Perspectives** (in press).

8. Koenig, J.Q., W.E. Pierson and M. Horike. 1983. "The effects of inhaled sulfuric acid on pulmonary function in adolescent asthmatics", **Am. Rev. Resp. Dis.** 128:221-225.

9. Leikauf, G.D., D.B. Yeates, K.A. Wales, D.M. Spektor, R.E. Albert and M. Lippmann. 1981. "Effects of sulfuric acid aerosol on respiratory mechanics and mucociliary clearance in healthy nonsmoking adults", **Amer. Ind. Hyg. Assoc. J.** 42:273-282.

10. Schlesinger, R.B., B.D. Naumann and L.C. Chen. 1983. "Physiological and histological alterations in the bronchial mucociliary clearance system of rabbits following intermittent oral or nasal inhalation of sulfuric acid mist", **J. Toxicol. Environ. Health** 12:441-465.

11. Lippmann, M., R.B. Schlesinger, G. Leikauf, D. Spektor and R.E. Albert. 1982. "Effects of sulphuric acid aerosols on respiratory tract airways", **Ann. Occup. Hyg.** 26:677-690.

12. Albert, R.E., M. Lippmann, H.T. Peterson, Jr., J.M. Berger, K. Sanborn and D.E. Bohning. 1973. "Deposition and clearance of aerosols", **Arch. Intern, Med.** 131:115-127.

BIOGRAPHY

Dr. Morton Lippmann is Director of the Aerosol and Inhalation Research Laboratory, and Professor at the Institute of Environmental Medicine, New York University Medical Center, New York.

Before he became associated with the Institute in 1964, he was an industrial hygienist for the U.S. Atomic Energy Commission, and the U.S. Public Health Service.

Dr. Lippmann received his Bachelor's degree in chemical engineering at the Cooper Union in 1954, and his Ph.D. in environmental health science and industrial hygiene at New York University in 1967. Dr. Lippmann is a member of different professional societies and society committees, the American Academy of Industrial Hygiene, the American Thoracic Society, and Chairman of the American Conference of Governmental Industrial Hygienists, 1982-83. He is the author and co-author of many publications.

THE HISTORY AND AQUATIC EFFECTS OF ACIDIC PRECIPITATION IN NORTHEASTERN U.S.: EVIDENCE FROM LAKE SEDIMENTS AND PEAT DEPOSIT

Stephen A. Norton, Ph.D.
Department of Geology
University of Maine

RÉSUMÉ

Des études d'échantillons de sédiments provenant de lacs du nord-est des États-Unis et de l'est du Canada montrent que la pollution par les précipitations remonte au milieu ou à la fin du siècle dernier. À preuve, les échantillons révèlent l'existence de concentrations et de taux d'accumulation croissants de plusieurs éléments tels le plomb, le zinc, le cuivre et le vanadium, éléments qui sont rejetés dans l'atmosphère par les industries. Les sédiments contiennent aussi des hydrocarbures aromatiques polycycliques et autres particules de substances associées à la consommation de combustibles fossiles. Des conclusions semblables mais moins précises sont tirées de l'analyse d'échantillons de tourbières ombrotrophiques.

La pollution atmosphérique dans l'est de l'Amérique du Nord a atteint ou presque atteint un maximum et a au moins cent ans d'histoire. L'acidification de l'eau des lacs par les dépôts acides provenant de la consommation de combustibles fossiles se manifeste par la diminution des concentrations et des taux de dépôts nets d'ions de métaux facilement libérés (dans l'eau à faible pH) comme le zinc, le manganèse et le calcium.

THE HISTORY AND AQUATIC EFFECTS OF ACID PRECIPITATION IN NORTHEASTERN U.S.: EVIDENCE FROM LAKE SEDIMENTS AND PEAT DEPOSIT

Stephen A. Norton, Ph.D.
University of Maine

I thank our host for providing us with such comfortable accommodations and I also thank the previous speakers for setting the table for me in the sense of introducing you to many concepts which will be useful in my talk. In particular, we have heard a number of phrases which I will build upon such as "It is only a matter of time" or "Sensitivity."

By injecting various types of pollutants into the atmosphere, not just SO_x and NO_x, but also lead, zinc, copper, and cadmium and all the other noxious things that we hear about, we are in the midst of a very long-term chemical experiment with the chemical climate of the northern hemisphere. It is unprecedented in scope. It is unprecedented in the time frame with which we are working. It is my hope to impart to you a better understanding of the time frame of this phenomenon of acidic precipitation.

My comments are based largely upon my research, but parallel conclusions have been reached by researchers in Canada, Norway, Sweden, and Finland. Thus, what I report to you is not unique. It is, in a sense, a generalization of our understanding of the history of acidic precipitation and its chemical effects on aquatic systems.

Let me take you back to the classroom for just a moment so that we can understand why certain aquatic ecosystems are sensitive to acidic precipitation.

The chemical equation shown below is the interaction of a mineral called calcite

$$CaCO_3 + H^+ = Ca^{++} + HCO_3^- \quad (1)$$

(in rock form it is called limestone) and a hydrogen ion (H^+), which is equivalent to acid. This reaction occurs rapidly and extensively, and the products are calcium in solution (Ca^{++}) and a negatively charged ion called bicarbonate (HCO_3^-). The process consumes acid. If we have this mineral calcite or the rock limestone present in any amount in our soils or in the bedrock, acid rain will be essentially neutralized by the terrain on which it is falling.

Conversely, if a terrain is underlain by minerals similar to SiO_2, quartz, that mineral reacts with water and produces dissolved silicic acid but it is innocuous. The equation for solution indicates that hydrogen ions are neither consumed nor produced:

$$SiO_2 + 2H_2O = H_4SiO_4 \quad (2)$$

If acid rain falls on a terrain composed largely of this mineral or minerals like it the groundwater and surface waters remain acidic. An intermediate case is present for the mineral orthoclase. Equations (3a) and (3b) represent two possible reactions under two different acidity regimes (3b would occur under more acidic conditions).

$$2KAlSi_3O_8 + 2H^+ + 9H_2O =$$

$$Al_2Si_2O_5(OH)_4 + 2K^+ + 4H_4SiO_4 \quad (3a)$$

or

$$KalSi_3O_8 + 4H^+ + 4H_2O = Al^{+++} + 3H_4SIO_4 + K^+ \quad (3b)$$

The bedrock geology of New England and the eastern Canadian provinces is quite varied. Some areas are underlain by rocks which contain calcite, and some are not. As a result there are areas which are highly sensitive to the input of acidic deposition and where we might expect to see an impact on surface water quality and thus the biota in those surface waters. Figure 1 is a map of the state of Maine showing the distribution of sensitive areas. The areas marked (1) are underlain by rocks and soils which characteristically do not interact appreciably with the acid rain and thus do not neutralize it. One might expect to find impacts in those areas. Successively higher numbers indicate lower sensitivity.

Other factors are also important in whether or not incoming acidity is neutralized, such as the amount and type of vegetation (see the accompanying paper by Professor Dudley Raynal,) the thickness of the soil, and the retention time of the water in the soil before it enters streams and lakes. Nonetheless, we can make a first approximation at the distribution of sensitive systems by just looking at a geologic map. Thus, one would not expect to find a large impact in a lot of lakes and streams in Maine but there will be some areas that will be sensibly altered by the input of acids.

One of the more famous areas in acid rain research is the Adirondack Mountain region in New York. The Adirondack Mountain region has complex geology but includes large areas with underlying bedrock and soils with low acid neutralizing capability. Those areas contain lakes and streams which are quite acidic and can be demonstrated to be acidic

largely because of atmospheric deposition. Similar heterogeneity exists in eastern Canada (see e.g. the work of Shilts or Elder).

Essentially all of northern Québec is underlain by a "sensitive" terrain. The Canadians should be and are concerned about the vulnerability of their aquatic systems.

My research has focused on the history of lakes that are located in these sensitive terrains. Some of the conclusions that I reach from studying these individual lakes cannot be generalized to all lakes, but rather only to those class of lakes which lie on sensitive terrain. One must keep in mind that we are looking at a very special subset of all lakes. This is true of many studies and must be considered when we generalize from observations.

A lake is essentially a settling basin where debris of all types settles to the bottom of the lake, accumulating as "mud" roughly about one millimetre per year. This sediment contains pollen which reflects the type of vegetation in the drainage basin as well as in the region; it may contain metals that are derived from the atmosphere or particulates (including pollen) derived from the atmosphere. There also are various minerals and organic particulate materials derived from the drainage basin which are washed into the lake and deposited in the sediment. Similarly, organisms live in the lake in the water column, and at the sediment-water interface. The types and abundance of organisms in part reflect the chemistry of the water. As the chemistry of the water evolves due to the input of various pollutants, so does the biota in the lake. This biota may also become part of the fossil record in sediment cores from lakes. Notably, fosil single-celled algae, called diatoms, reveal to us a great deal about the pH history of lakes in "sensitive" regions. Thus the sediment records, in a magnetic tape fashion, the history of the lake.

Cores of sediment approximately 50 or 60 centimetres long are retrieved from the deepest part of study lakes. If sediment accumulates at approximately one millimeter per year, 50 centimeters of sediment should encompass approximately a 500-year history for that lake; this is a sufficiently long period to study the history of anthropogenically influenced atmospheric deposition.

The sediment core is sliced into slices 0.5 cm thick (ca. 5 years), each of which is analyzed for its biological and chemical remains and assigned an absolute age using the distribution of radioactive material in the core.

Figure 2a and 2b represent data from a sediment core from Jerseyfield Lake in the Adirondack Mountains of New York. The concentration of various constituents as a function of sediment depth (or age) is shown on each of the small graphs. For example, the concentration of vanadium is relatively constant from 1600 A.D. until about 1940 when there is a dramatic increase in the concentration. This trend for vanadium is ubiquitous and synchronous all over the northeast. It must be related to the input of this metal via atmospheric transportation and deposition and we can link it with the emissions relating to oil consumption. Vanadium is a very common and abundant constituent in oil. We see a reflection of the increased consumption of a fossil fuel and the emission and deposition of one of the ingredients of this fossil fuel well downstream, in terms of the airshed, in lakes that are relatively remote from point sources of pollution.

The concentration of copper starts increasing about 1900, well before vanadium. It increases in concentration in the sediment nearly to the present.

Zinc parallels copper, being relatively constant from 1600 A.D. until about 1900 or slightly before; therefore, it increases sharply and then decreases. This pattern repeats again and again in every acidic lake (for the lakes which are not acidic, the zinc continues to increase right to the surface). Sometime between 1940 and 1950 the lake and/or the drainage basin apparently became sufficiently acidic so as to dissolve zinc from detritus and sediment. Alternatively, zinc may diffuse downward from the overlying water column into the sediment and be deposited below the sediment-water interface. In this case, the concentration profile would not be an accurate historic record of atmospheric deposition. About 1950, the last fish were caught in this lake, indicating a concurrence of mobilization of certain elements (e.g. zinc) and the loss of the fish, presumably related to increasing acidity of this lake. The concentration of CaO (Figure 2) declines in recent sediment more sharply than any of the other elements. This is interpreted as evidence in support of the postulated acidification of that lake. The lake was limed in 1961 with no long term effect on the acidity status and no chemical record in the sediment. Fossil algae do record this event.

The pattern for the concentration of lead (Figure 2) repeats in lakes over the northeastern U.S., eastern Canada, and southern Norway, Sweden, and Finland. We see a very strong signal starting in the late 1800's and increasing almost to the present. The profile for lead does not reflect only the consumption of fossil fuels, because fossil fuel consumption, particularly coal, has leveled or even decreased. Other inputs to the atmosphere, notably tetraethyllead (the additive in gasoline) and smelting are important. The consumption and emission of lead have now decreased. Cores from most lakes indicate that the deposition of lead in the lakes is declining or steady instead of increasing.

We know the absolute age of intervals of sediment and the amount of matter in each slice of sediment. Thus, we can calculate the net accumulation rate at which these metals are being deposited in the sediment (from the atmosphere). Figure 3 shows the net accumulation rate of lead at a particular spot in Jerseyfield Lake in the Adirondacks. Background rates of deposition starting around 1600 A.D. reflect lead coming from the watershed as well as redeposited older sediment. Background deposition rates are constant at about 0.1 μ g/ cm^2/y until the mid- to late - 1800's; thereafter the accumulation rate of lead increases due to atmospheric deposition of this pollutant.

A similar shaped curve exists for vanadium but the increase occurs much later and is not related to the consumption of coal so much as it is related to the consumption of oil. We are able to sort out the signals of the different fuels and the different sources.

For zinc, the sharp increase starts in the late 1800's, peaks and then declines. The decline is believed to be partly related to acidification of the lake. A decline in the net deposition rate of zinc is not present in non-acidified lakes.

Other constituents are present in lake sediments as well and reflect various types of emissions of pollutants. These include particulates such as magnetic spherules, carbonaceous spheres, glassy spherules, and soot particles. Each of these reflect different sources and different emission histories. Chemical compounds such as polycyclic aromatic hydrocarbons (PAH), produced by low temperature inefficient combustion of coal and emitted to the atmosphere are also deposited in sediment. Essentially, there is very little or no PAH in prehistoric times and in the last 100 years we have sharply increasing amounts being deposited in our lakes.

If we move to a different ecosystem, ombrotrophic peat bogs, we have a unique opportunity to look at the history of atmospheric pollution. Ombrotrophic bogs receive all of their nutrients from the atmosphere. There is no unput from the ground, from contact with mineral soils. Peat bogs grow upward at a measureable rate and as they grow the various plants in the peat community incorporate various constituents from the atmosphere into and onto their cells. Chemical profiles of the fossil peat material can be used to reconstruct the history of the deposition of some pollutants on the bog surface.

Figure 4 shows a core of peat from such a bog in Maine. These must be interpreted with great caution. As peat dies and is buried by growing peat, many elements are recycled, just as they are in the forest. So, for example, the calcium profile in the center of the figure cannot be related directly to what is being deposited from the atmosphere, because calcium moves up and down as biological needs dictate. Similar processes affect the distribution of Mg, Mn and K. Other elements such as Fe and Mn are moved about by inorganic processes. The concentration profiles for lead and vanadium resemble those found in lake sediments. The net accumulation rates (Figure 5) indicate a history of atmospheric deposition similar to that inferred from lake sediments.

BIOGRAPHY

Dr. Stephen A. Norton is a Professor of Geological Science and Interim Dean of the College of Arts and Science at the University of Maine at Orono.

He received his Bachelor's degree in geology from Princeton University in 1962 and his Master's and Ph.D. in geology from Harvard University in 1963 and 1967, respectively. From 1961 to 1972 he served with the United States Geological Survey as a geologist, performing field investigations. He has been at the University of Maine at Orono since 1968 and has studied the effects of acid rain since 1975. He is the author and co-author of many publications.

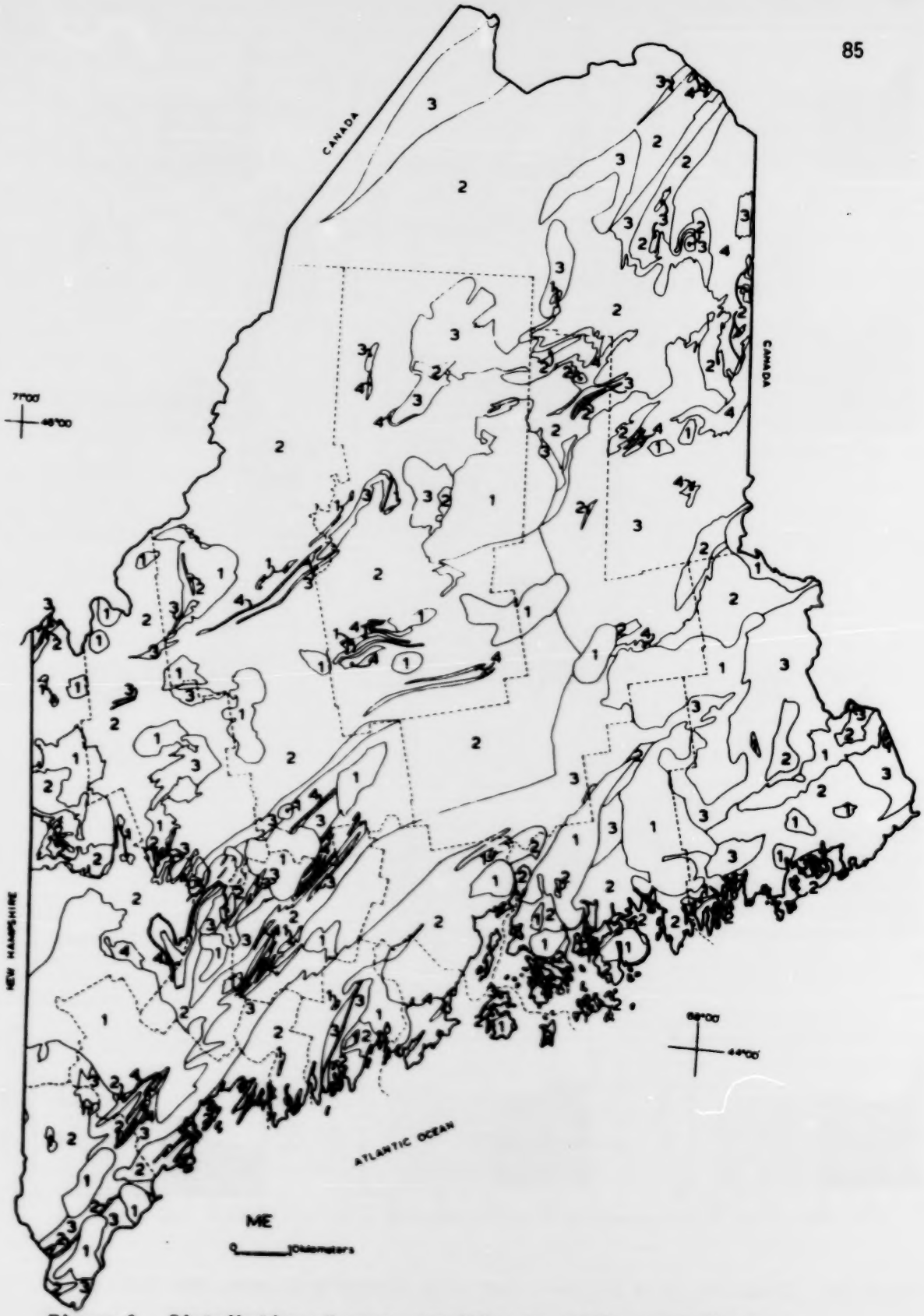


Figure 1. Distribution of areas sensitive to acidic precipitation in Maine, based on bedrock geology.

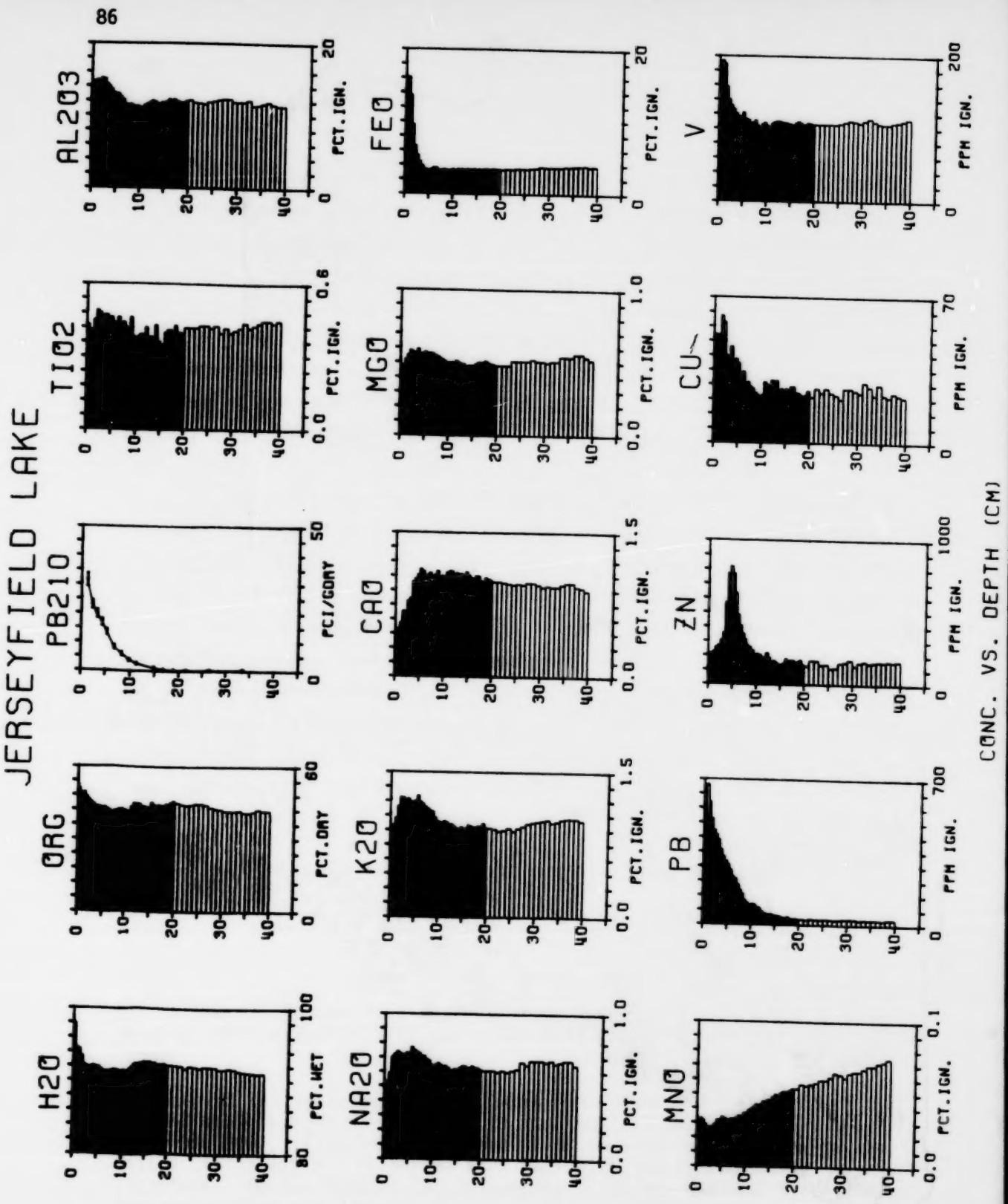


Figure 2a. Chemistry of a sediment core from Jerseyfield Lake, New York.

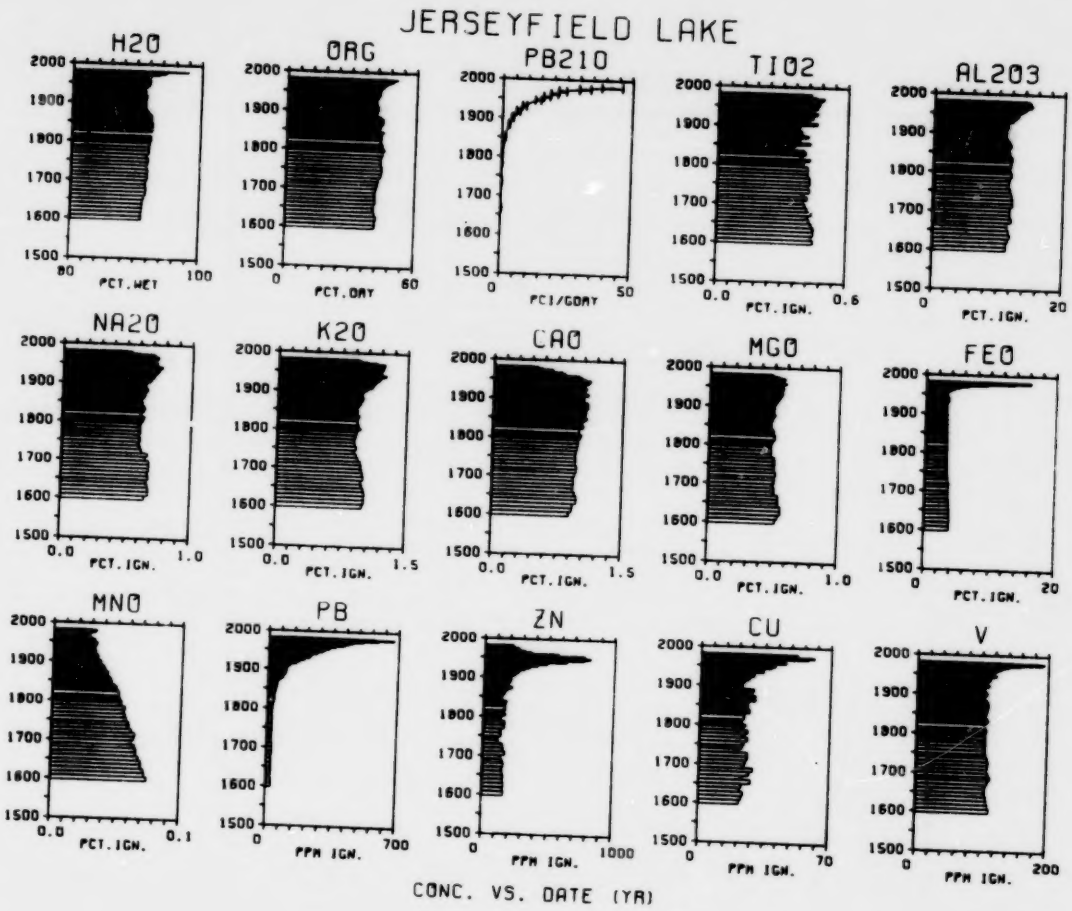


Figure 2b. Chemistry of a sediment core from Jerseyfield Lake, New York.

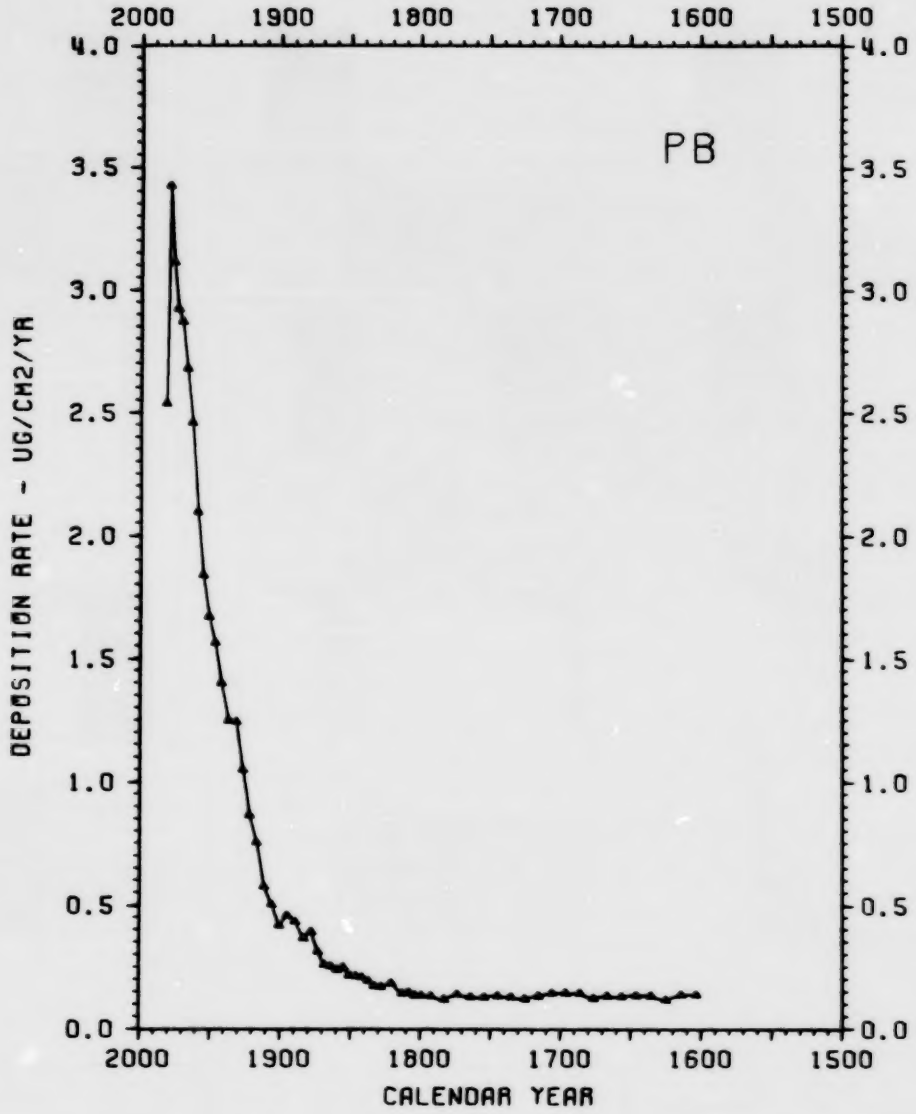


Figure 3a. Net accumulation rates for Pb, at the coring site in Jerseyfield Lake, Adirondack Mountains, New York.

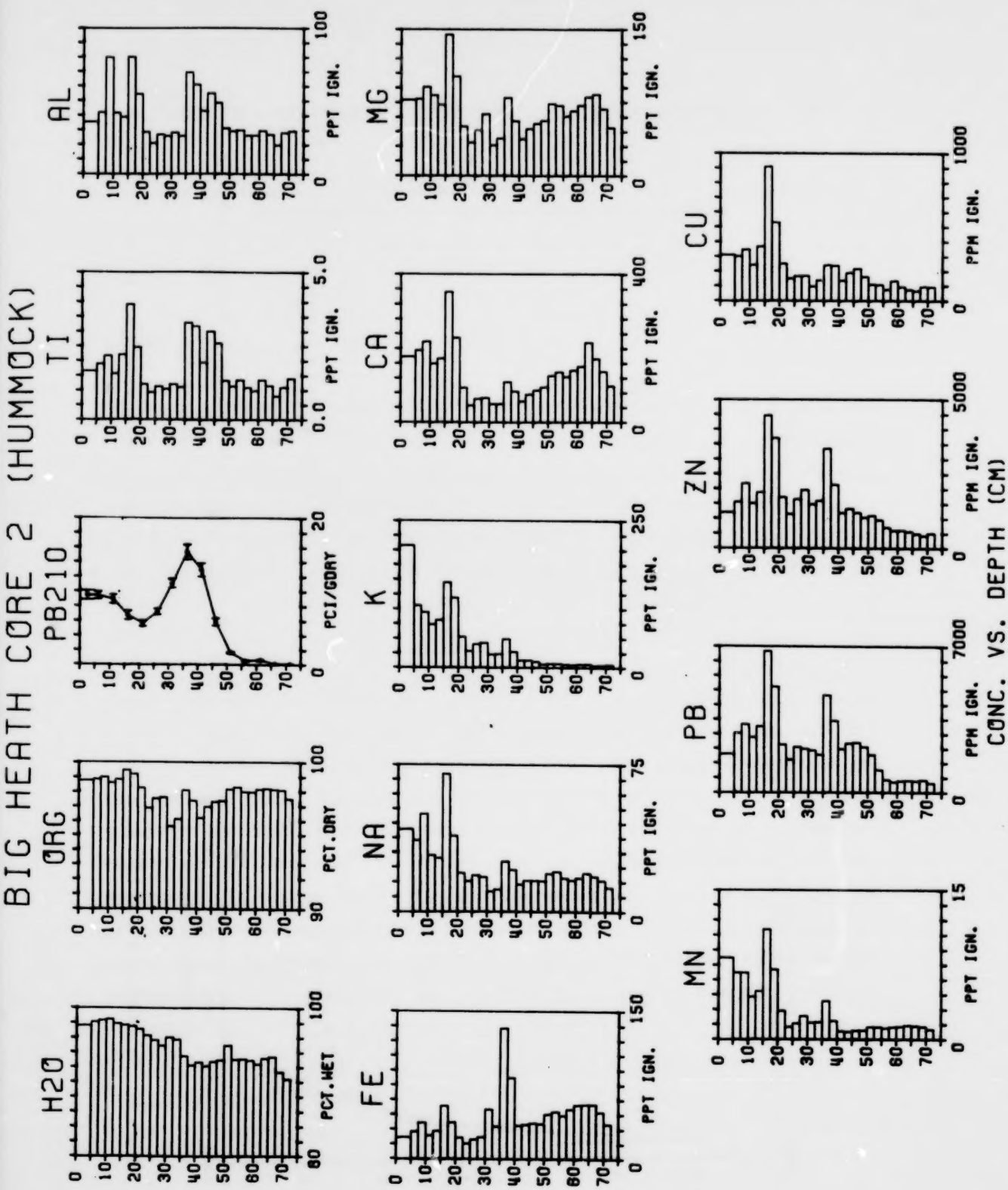


Figure 4. Chemistry of a peat core for a hummock in ombrotrophic Big Heath bog, Mt. Desert Island, Maine (Core BH2)

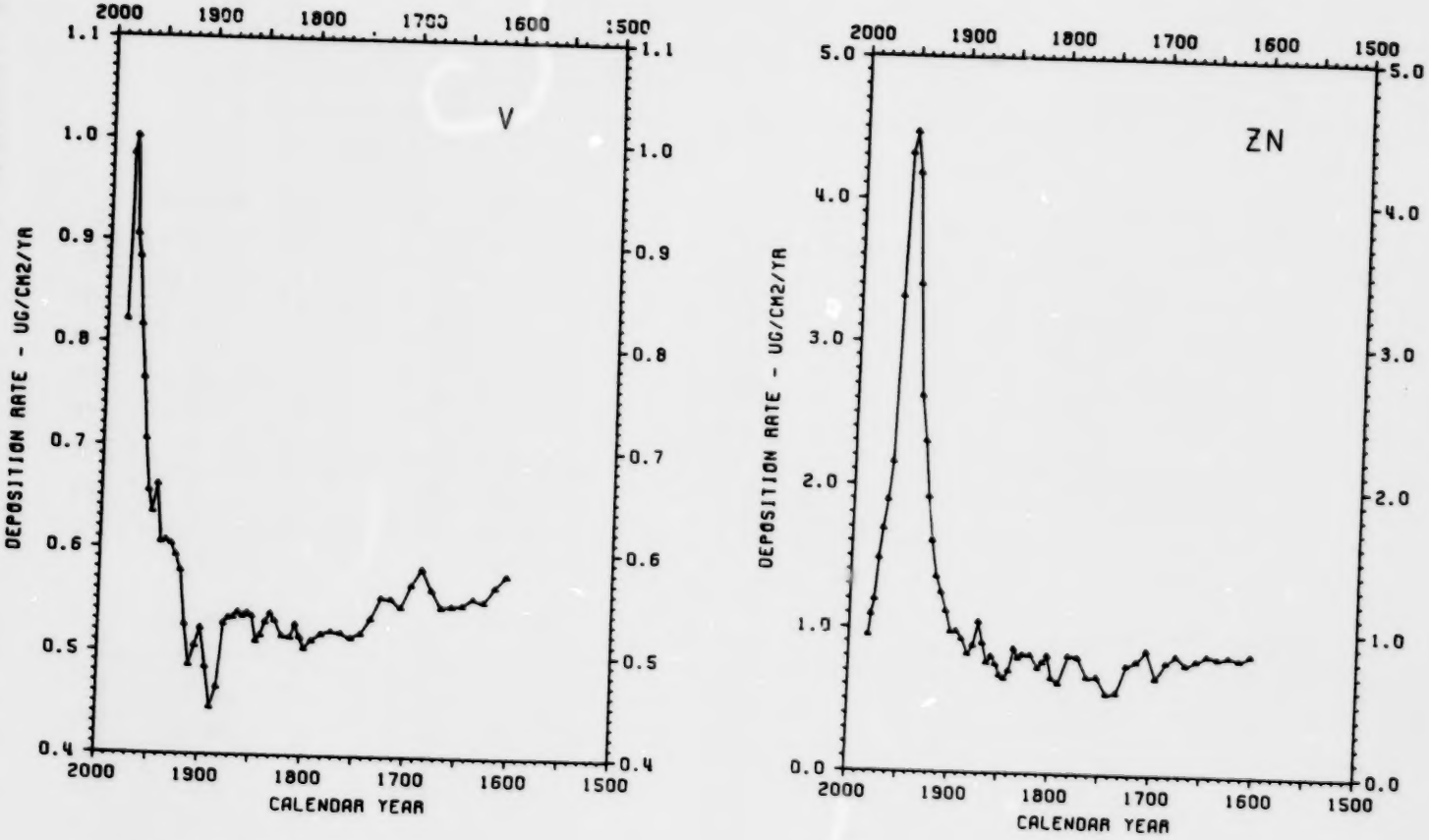


Figure 3b. Net accumulation rates for V et Zn at the coring site in Jerseyfield Lake, Adirondack Mountains, New York.

ACID RAIN AND AQUATIC ECOSYSTEMS: THE TARGET LOADING QUESTION

Eville Gorham, Ph.D.
Department of Ecology and Behavioral Biology
University of Minnesota

RÉSUMÉ

En dépit d'arguments scientifiques sur le mécanisme et la vitesse d'acidification des lacs par les dépôts acides, il serait à la fois possible et approprié d'aborder les mesures de réduction de façon empirique. Les émissions d'anhydride sulfureux doivent être suffisamment diminuées pour éviter que les dépôts humides de sulfates de l'atmosphère ne dépassent une charge limite déterminée de façon empirique afin de protéger les lacs de l'acidification et de la perte des populations naturelles de poissons.

Selon une analyse récente de la chimie des précipitations de l'est de l'Amérique du Nord, une charge limite d'environ 15 kilogrammes par hectare par année (kg/ha/an) serait appropriée. Selon des expériences effectuées en Suède, des charges limites encore moins élevées pourraient s'avérer nécessaires en Scandinavie pour protéger les lacs extrêmement sensibles qui ont une faible capacité de neutralisation des acides. Néanmoins, la charge limite de 20 kilogrammes par hectare par année demandée récemment par les scientifiques canadiens représenterait une première étape importante, à partir de laquelle on pourra, après examen, perfectionner des scénarios de réduction si d'autres restrictions sont souhaitables.

ACID RAIN AND AQUATIC ECOSYSTEMS: THE TARGET LOADING QUESTION

Eville Gorham, Ph.D.
University of Minnesota

Because the sources of acid deposition are widespread, and emissions from such sources are transported over hundreds of kilometers within a few days, "acid rain" is clearly an international problem requiring joint action by Canada and the United States. The prerequisite for action is agreement on a target substance, and emission and deposition standards for that substance, as a focus for control. Sulphur dioxide - the major pollutant emitted in the combustion of fossil fuels and the smelting of metal ores, and the sulphate to which it is transformed in the atmosphere, are clearly the best targets for emission and deposition standards. First, the free hydrogen ions that are the measure of acidity are much more closely associated with sulphate than with nitrate, the product of nitrogen oxides that are also emitted - but to a lesser extent - during the combustion of fossil fuels. Second, techniques for reducing emissions of sulphur dioxide are better researched and more readily available than are methods for the control of nitrogen oxides.

If a sulphur deposition standard is to be set up for the protection of our lakes and streams (as demonstrated chiefly by the maintenance of native fish populations), then sulphate falling as wet deposition (i.e., in rain and snow) is the only component that can presently serve our purpose. Dry deposition of sulphur dioxide and the impaction of sulphate aerosols upon forest canopies cannot now be measured with sufficient accuracy to allow the setting of a standard for total sulphur deposition. The question, then, is whether a reasonable standard for wet sulphate deposition can be agreed upon by the two countries.

Despite considerable argument among scientists about the applicability and effectiveness of several models for the process of lake acidification (e.g., those of Henriksen, Thompson, Galloway and Schnoor), it is relatively straightforward to establish an empirical basis for a target loading of wet sulphate deposition. To the best of our present knowledge, the recent acidification of clearwater lakes on rocks and soils with a low capacity for neutralizing acids is observed only in areas where the annual weighted average acidity of atmospheric precipitation is below a pH of 4.6, or perhaps 4.7 in the opinion of some scientists. If 4.6 is taken as the annual average pH below which atmospheric precipitation should not fall, then a recent analysis of wet deposition in the United States east of the Mississippi River indicates that wet sulphate deposition should not rise above 16 kilograms per hectare per year. If pH 4.7 is the chosen figure, then wet sulphate deposition should be restricted to no more than 14 kg/ha/yr. Both figures are well below the limit of 20 kg/ha/yr sought by Canadian members of the joint task force set up under the Canada/U.S. Memorandum of Intent on Transboundary Air Pollution, but rejected by the U.S. members - apparently under severe political pressure. Swedish experience also suggests the desirability of a target loading well below 20 kg/ha/yr. Nevertheless, the figure of 20 kg/ha/yr represents a very substantial first step, following which the desirability of further restrictions can be debated and determined.

This indirect approach to a target loading for wet sulphate deposition through its relationship to the pH of atmospheric precipitaation, which is related in turn to the occurrence of lake acidification below pH values of 4.6-4.7, should be complemented in North America by a more direct approach of the kind employed by William Dickson in Sweden. He has developed a series of graphic relationships between lake-water pH and wet sulphate deposition from the atmosphere that take into account the acid-neutralizing capacity of the lake water as indicated by its

content of non-marine calcium and magnesium. In pristine landscapes these ions are largely balanced by bicarbonate, the chief buffer against acidification in lakes of circumneutral pH. Dickson provides a series of four curvilinear relationships between average lake pH and wet sulphate deposition (with estimates of total deposition added), each curve representing waters of differing acid-neutralizing capacity. For extremely sensitive lakes of the lowest capacity (non-marine Ca + Mg = 20-90 microequivalents per litre), lake pH declines below 6.0 when annual wet sulphate loading exceeds 6 kg/ha. Lakes in the next lowest group (non-marine Ca + Mg = 110-160 ueq L^{-1}) acidify below pH 6.0 when sulphate loading exceeds 15 kg/ha. In lakes of the highest acid-neutralizing capacity (non-marine Ca + Mg = 320-370 ueq L^{-1}), pH does not decline below 6.0 until sulphate loading exceeds 34 kg/ha. There are of course lakes in calcareous terrain that can tolerate much higher levels of acid deposition without their waters becoming acidified. Lakes in these three of Dickson's four groups reach a pH of 5.5 - often regarded as a danger threshold for serious losses of fish populations - at annual wet sulphate depositions of about 8, 21 and 36 kg/ha respectively. However, it may be very difficult to hold lake pH at this level, because as a lake's base-neutralizing capacity is titrated away by acid deposition, pH can fall rather suddenly from above 6.0 to near 5.0, making the maintenance of an intermediate value rather difficult.

An empirical approach of this kind to environmental problems such as "acid rain" must not be ignored while researchers attempt to dot the last "i" and cross the last "t" in the scientific chain of causation. Even if control legislation were enacted today, it would probably take at least five and more, probably ten years to begin having a really significant effect upon emissions. In the meantime, as we have learned with our lakes and as the Germans are learning with their forests, fragile parts of the natural environment that supports us all are likely to suffer serious damage that we can ill afford. Moreover,

the damage will not be restricted to our lakes, streams and forests, but will include very substantial and expensive corrosion damage to metals, building stone, mortar and other materials close to the sources of emissions. We must also be greatly concerned about the unproven but likely damage to human health from air pollutants released by fossil-fuel combustion near to the emission sources.

It is not too soon to act; the scientific evidence is overwhelming as regards actual and potential damage, and all that is needed is the political will - and goodwill - of our two countries. Let us agree now to legislate both deposition and emission standards, and to put them into effect. We can then fine-tune our control strategies in line with the research data that will continue to come in on both sides of the border. In that way we can remain good friends, and our environment will recover to the healthy state that is surely the shared hope of Canadians and Americans alike!

BIOGRAPHY

Eville Gorham was educated at Dalhousie University, Halifax, Nova Scotia, and the University of London, England. He did postgraduate work at the State Forest Research Institute in Stockholm and the University of Uppsala in Sweden, and has taught at the Universities of London, Toronto, Calgary and, since 1962, Minnesota, where he is presently Regent's Professor of Ecology and Botany.

He was one of the first researchers to look into the problem of acid precipitation and to direct his work on the ecological significance of atmospheric depositions such as dusts, and industrial and urban pollutants for lakes, bogs and forests.

His most recent work, a statistical study of the chemistry of precipitation in the eastern United States, suggests the need for reductions in sulfur deposition even greater than those proposed by Canadian scientists to protect lakes and streams sensitive to acid deposition.

Professor Gorham was one of four authors of A National Program for Acid Rain, a report prepared in 1978 for the President's Council on Environmental Quality. He recently served as a member of the Committee on the Atmosphere and Biosphere of the U.S. National Academy of Sciences, and of two review panels for the Royal Society of Canada. He is currently a member of the Tri-academy Committee on Acid Deposition, sponsored by the U.S. National Academy of Sciences, the Royal Society of Canada, and the Mexican Academy of Sciences.

ADDRESS

John H. Sununu
Governor of New Hampshire

RÉSUMÉ

John H. Sununu présente les efforts réalisés aux États-Unis pour combattre les précipitations acides. Un bon nombre d'États incluant celui du New Hampshire ont légiféré ou s'apprêtent à le faire pour réduire leurs émissions d'anhydride sulfureux. Il se dit étonné que l'on proteste de ce côté-ci de la frontière du manque d'action des Américains. Il souligne à cet égard que le "Clean Air Act" a réduit les émissions américaines d'anhydride sulfureux de 30 millions de tonnes par année à un niveau égal ou légèrement supérieur à 25 millions. Le gouverneur du New Hampshire fait également valoir que les États-Unis émettent cinq fois plus de polluants que le Canada mais que per capita, les émissions canadiennes sont deux fois plus élevées que les émissions américaines. Sous cet angle, le Canada n'atteindra le niveau américain qu'en 1994. Il souhaite fortement que le Canada atteigne cet objectif et poursuive cet effort d'assainissement.

John H. Sununu demande de prendre en considération les réalités politiques des deux pays. Il présente les efforts qu'il a réalisés depuis deux ans avec les gouverneurs Earl et Dukakis pour faire avancer le dossier au niveau fédéral américain. Enfin, il exprime sa satisfaction devant la tenue de cette conférence et il souhaite que l'on fasse une juste évaluation de ce qui a été fait et non fait pour combattre les précipitations acides tant au Canada qu'aux États-Unis. (E)

ADDRESS

John H. Sununu

Governor of New Hampshire

Thank you very much. I apologize for the disruption to the flow of the program and I thank you for the opportunity to make a couple of points that I hope might lead to some action that reflects the desires and intentions of most of the people involved in this conference.

I am aware, as all of you are, that most issues of this nature have a technical, economic and political component. If we look at the program, we see evidence of the growing body of data emphasizing the technical reality of the issue. If you look at the information that is being provided almost on a daily basis, there is a clear definition of the economic needs which mandate action and the economic costs associated with taking remedial action to deal with those needs.

I would like to address myself to the political reality of gaining action. Domestically, within my own country, there is a political reality involved in the process of achieving success in dealing with acid rain. Governor Earl and I have had legislation filed that creates the kind of political coalitions that are necessary to achieve success.

Governor Dukakis in his presentation pointed out that the New England governors and the Northeastern governors have made an effort to continue what has been an historic trend within our region and within our states to achieve results commensurate with our recognition of the problem by a continued reduction of emissions within our own states under existing legislation. A number of states, and certainly in my state we have done this, filed legislation that will in fact increase

beyond the 40 to 45 percent reductions that have already been achieved in our regions.

We are gathered here, however, because we are not just talking about domestic actions but seeking to achieve international cooperation as well. Certainly the United States alone could address its problem and eventually produce a scenario of action that would achieve results. Certainly Canada alone could do so. But, we recognize that there is across our boundary, across our borders, a need for cooperative action. I suggest that we dwell on some of the issues that might promote a successful relationship.

Without a doubt, the total amount of emissions in the United States is greater than in Canada. However, much too much has been made or much too little has been made of the reality of the proportionate share. Although I have raised this issue over the past year and a half, I must say again that I feel it is dismissed too lightly by those who choose to focus on just one aspect of the data. If you truly seek international cooperation there must be a fair and constructive assessment of how we are going to achieve a program that is fair in its sharing of responsability, in its sharing of cost and is accountable for constructive results already achieved. If we continue to choose to dismiss those realities then I suspect the rhetoric will continue and the action will never come.

Certainly you have begun to address some of the needs in the plan you have laid out. There are those of us who feel that the action on terms of transportation is long overdue north of the border and we applaud the commitment that has been made to deal with the nitrogen oxide emissions coming from automobiles. There are those of us who feel that the Clean Air Act in the United States, which has reduced total emissions of sulfur oxides in our country from 30 million tons per

year to levels in the mid or high 20's, deserves some credit and accountability in the rhetoric and in the plan for action. And there are those of us who feel that you have taken a good step in Canada in focusing on your smelters as the areas for greatest reduction potential, and we regard it as appropriate because of the quantity of emissions. We also realize that in exporting a product you can export costs for cleanup. We wonder if you protest too much on lack of action from our side of the border.

I have pointed out in the past and I will reiterate it here, that yes, the United States has five times the total emissions as Canada, but we have ten times the population and therefore your emissions per capita are twice as large, twice as large as ours. Canadian emissions per unit of industrial output are close to three times as large. We will and I will continue to move for action on my side of the border to have significant reductions, but I point out to you, in light of the statistics I have just presented, that when you, and if you, achieve your goals in 1994, then you will, on a per capita basis, be just where we are today.

You have taken a good first step and I hope you move forward and accomplish what you have laid out. I hope that in catching up to us in 1994 you will then accept again the kind of commitment that we in our country are willing to accept today and that is a commitment to move forward even more aggressively.

Everything we have seen presented so far and that you will see today accentuates the need for action. Everything that I have done on this issue for the last two years, and Governor Dukakis and Governor Earl and other actively involved political figures on our side of the border have done, will be directed towards getting positive action at the federal level in our country. I remind you that we also must

understand the difference in the political realities in our two nations. Where on our side of the border states can propose and take some actions to dispose, the fundamental disposition has to come at the federal level. On the contrary, I have been told the tradition in Canada is that goals are proposed at the federal level, and acted on at the provincial level. It is appropriate to take a strong position when the only responsibility is stating of goals. It is more difficult for our federal government to respond and to act because they are not dealing with goals but stark political, economic and environmental reality. I ask you to take that into consideration as you compare what has been done in both countries and what you suggest ought to be done.

I am committed to action and I am committed to work to achieve that action. I suggest to you that the heat of the political rhetoric today, in terms of an international agreement, is more of an impediment than a catalyst to that action. I will continue to push for the legislation in my state that moves us beyond the 40 percent reductions we have already achieved in the Northeast. We are seeking an additional 25 percent. I make that commitment. I ask that in Canada you make not only the commitment to catch up to where we are today by 1994, but that you make the commitment to go beyond that, too.

I think we recognize that we are partners on a continent, but more than partners, we are friends. I urge you when you come to the table as a friend and come to seek action that you come with a realistic assessment of what you have done and not done. Make a realistic assessment of what we on our side of the border have done and not done. I am willing to continue in this strong effort to make sure that this ecological insult is mitigated. But, we must make a choice as to whether we will move for international action or whether we will continue to be stalemated by international rhetoric.

I am very pleased this conference has taken place. It allows for an exchange of perspectives and that is important. It brings additional focus to the issue, and that is important, too. I and other governors in the National Governors' Association and governors in the regional associations concerned with these problems will continue to press on our side of the border. I hope that your proposals can be turned into reality north of the border. I applaud you for making a very significant effort to get within the next decade at a level commensurate with where we on our side are today.

BIOGRAPHY

Governor of the State of New Hampshire since 1983, John H. Sununu has a background in education, engineering and business. He earned his Ph.D. in mechanical engineering from the Massachusetts Institute of Technology in 1966. From 1968 to 1973, he was associate dean of the College of Engineering at Tufts University where he was an associate professor of mechanical engineering since 1966. Since 1984, he sits on the Advisory Board of the Technology and Policy Program at MIT.

Since assuming office as governor, John H. Sununu has earned a seat on the executive committee of the National Governors' Association (NGA). He is vice-chairman of the NGA Committee on Energy and Environment and also serves on the Committee on Economic Development and Technological Innovation, and the Committee on Transportation, Commerce and Communications.

ADDRESS

John A. Fraser
Minister of Fisheries and Oceans Canada

RÉSUMÉ

Le débat canadien sur les précipitations acides au Canada porte sur la façon de protéger les écosystèmes modérément sensibles et d'atteindre l'objectif environnemental de 20 kilogrammes par hectare par année. La décision prise par le gouvernement fédéral et les provinces canadiennes de réduire de 50 pour cent d'ici 1994 les émissions d'anhydride sulfureux vise l'atteinte de cet objectif. Le Canada ne peut cependant rejoindre cet objectif seul. Le fait que deux émissaires extraordinaires aient été nommés s'avère une indication formelle de la reconnaissance du problème et de la volonté d'agir des deux pays pour le régler. La province de Québec qui est une région réceptrice démontre à cet égard un leadership considérable de ce côté-ci de la frontière.

John A. Fraser demande que lors des discussions qui se tiendront au cours de cette conférence, les participants tiennent compte des engagements pris par le gouvernement fédéral et les provinces canadiennes pour combattre les précipitations acides et n'entrent pas sur la base de qui est à blâmer. Le Canada qui est une société industrielle tire des bénéfices de cette société et doit également en payer le prix. (E)

ADDRESS

John A. Fraser
Minister of Fisheries and Oceans Canada

Monsieur le Président, il me fait grand plaisir d'être ici aujourd'hui comme représentant du ministre de l'Environnement du Canada, madame Suzanne Blais Grenier. Cela fait d'autant plus plaisir que j'ai moi-même occupé ce poste il y a quelques années.

C'est également un plaisir du fait qu'on ait reconnu la nécessité d'une conférence qui met en valeur l'importance d'entretenir un dialogue continu entre les Gouvernements des divers provinces et états. Le Canada et les États-Unis ont des intérêts communs, il est donc aisé de comprendre l'utilité et la nécessité de cette conférence intergouvernementale.

The government of Canada considers its relationship with the United States extremely important; however, as regards the matter of acid rain, before there can be any steps taken between the two countries, Canada must act on its own, or in a sense unilaterally, in order to properly address and assess the problem nationally. The steps recently taken by the government on the environmental front to reduce sulfur dioxide emissions illustrate this firm desire. Only then shall Canada be able to embark on a joint mission with the United States to solve the transboundary problem.

To Canada, the relevant debate is how to achieve what is needed to save the moderately sensitive aquatic ecosystems in central and eastern Canada and how to attain a target loading of 20 kilograms per hectare per year. The decision that has been made by the federal and provincial governments to jointly commit themselves to a program of

reduction of sulfur dioxide emissions by approximately 50 percent by 1994 will be a particularly useful contribution to reaching that target.

Admittedly, Canada cannot reach that target alone. Hence, Prime Minister Mulroney and President Reagan have appointed two distinguished envoys to consider means by which the two countries can work together towards the common goal of solving the acid rain problem. This extraordinary approach is a true measure of the friendship which unites both nations. Personally speaking however, I hope that the rhetoric may be restrained. I have no doubt most people are aware that we have a problem. Moreover, the very fact that the President of the United States and the Prime Minister of Canada could come together in a joint statement and appoint distinguished envoys to address the problem, is, I believe, a formal indication that both of us, Americans and Canadians, acknowledge that there is a problem and that our people want us to do something about it.

It should be noted that the province of Québec, this Conference's co-host, has naturally enough, being a receptor area, shown significant leadership on the Canadian side of the border. As such, I should like to extend to Prime Minister Lévesque the well-deserved appreciation of Canadians and Americans alike.

With respect to the point of unilateral action which I mentioned briefly at the onset, I suppose one could argue that it is not unilateral because there have been reductions in sulfur dioxide emissions in both countries. However, the reason why Canada is moving unilaterally and the reason why the provinces and the federal government are now committed to working together is that we believe it is only a matter of time before we are able to work on a joint strategy with the United States. We have faith in the good sense and decency of our neighbours and best friends.

We all know that there is a cross-boundary constituency, and at the risk of doing something that no politician shoud ever do, I am going to reread just a few lines of an address which I was asked to give at Columbia University in 1981. "There is, I think, another dimension to the question and it is this. A shared environment, which clearly we have, really means that there is also a cross-boundary political constituency. The millions of Americans and Canadians who make up this constituency do not have the ties of common citizenship, but they do have the ties of common concern. More and more this constituency is considering it legitimate to influence political decisions in either country, and this is not surprising. Our peoples know each other probably better than any other two peoples in the world. We share the same dedication to freedom, rule of law and fair play. We do an immense amount of business together. We travel and holiday in each other's countries. We share in fact, if not in ownership, the same continent and what diminishes one country diminishes the other.

We are, to a remarkable degree friends, in the real, not just diplomatic sense of that word. It is natural that a shared environment is leading to a common constituency and this common constituency cannot be ignored by politicians on either side of our border. It does not threaten our respective sovereignty. It will, I believe, help to ensure that we remain friends and good neighbours."

Now, five years later, I believe this meeting indicates that what I was trying to say then is in fact happening over and over again. Hence, I would urge that in your deliberations today, you take note of what the federal government of Canada and the provinces are committed to do, and that we, Canadians, do not enter into these discussions and exchanges with you on the basis of who is to blame for what. We too are an industrial community. We have reaped the benefits and we must pay the price, all of us. But to our American friends present today, I want

to say that it is the purpose and great desire of the government of Canada to enter into discussions with you on this issue intelligently, carefully, with attention to detail and to facts, and in a spirit of good humour, common interest and concern.

I am sorry that Madam Blais Grenier could not be here today, but I know that she would have approved of all that I have said. I equally know that the Prime Minister would be very anxious that none of you leave this conference without having clearly understood the message the government of Canada wishes to communicate to its American counterparts.

The issue of the cross-boundary constituency is here to stay, and as I have already said, it does not in any way affect, touch, or diminish the sovereignty of either of our countries. However, as was pointed out earlier this morning, acid precipitation or acid rain or pollution knows no boundaries. We share the continent together and this is just another of the many challenges that our peoples have had to face and overcome during the many decades and centuries that they have been here, in North America. I am confident that as a consequence of meetings such as this, and the discussions that are going to take place between Mr. Lewis and the Honorable Bill Davis, that we will find an answer to the problem.

Therefore, I ask that you continue your deliberations with optimism, with determination, with vigour and enthusiasm, and that you always remember that in this room are people of two different countries, but people who share the same continent and who are, in a very real sense, best friends.

BIOGRAPHY

Born in Yokohama, Japan on December 15, 1931, John Allen Fraser is a lawyer. He received his law degree from the University of British-Columbia in 1954 and was called to the B.C. Bar in 1955.

First elected to the House of Commons in the General Election of 1972, John A. Fraser was appointed Minister of the Environment and Postmaster General in 1979. He was Minister of Fisheries and Oceans from November 1984 to September 1985.

He has also served as the Caucus spokesperson for Post Office matters, Labour, Environment. As well, he served on the Parliamentary Special Committee on Acid Rain. He is the former chairperson of the PC Party Committee on Pollution and the Environment and Fisheries.

John A. Fraser was also chairperson of the Environmental Law Subsection of the Canadian Bar Association. Prior to his election to the House of Commons, he was affiliated with the Arbutus Club, National and Provincial Parks Association, the British Columbia Wildlife Association. He is also a member of the Trilateral Commission.

DEUXIÈME SÉANCE / SESSION II

RELATIONS ENTRE LA SCIENCE ET L'ÉLABORATION DE POLITIQUE/ SCIENCE AND POLICY RELATIONSHIPS

Président/Chairman
Mr. Henry G. Williams
Commissioner of the Department
of Environmental Conservation
New York

ACID PRECIPITATION DAMAGE IN EUROPE: REPORT ON A SURVEY BY THE NATIONAL GOVERNORS' ASSOCIATION

Anthony S. Earl
Governor of Wisconsin

RÉSUMÉ

Le gouverneur du Wisconsin, Anthony S. Earl présente différents aspects du débat qui se tient présentement en République fédérale allemande sur les précipitations acides et informe les participants des leçons qu'il faut tirer de l'expérience allemande. Les dommages causés à la forêt allemande sont la manifestation extérieure d'un stress accumulé depuis des années par les arbres. Lorsque le dommage apparaît, la bataille est perdue, signale le conférencier et la seule stratégie qui demeure est de protéger les plus jeunes arbres en prenant des mesures pour réduire les polluants. C'est ce qu'ont fait les Allemands en légiférant pour diminuer les émissions d'anhydride sulfureux et d'oxydes d'azote.

Des dommages sont aussi constatés dans les forêts du Québec, de l'Ontario, du Vermont et des Appalaches. Selon le gouverneur du Wisconsin, il faut apprendre à développer une technique commune pour évaluer les dommages causés par la pollution. Un autre constat est que les recherches ne doivent pas se substituer à l'action politique. La pollution de l'air est nuisible à la santé humaine et aux ressources naturelles et il faut agir dès maintenant. Un autre aspect du débat allemand est le partage des coûts. Le conférencier explique ce qu'implique en Allemagne le principe du pollueur-payeur. Il se dit également impressionné par les technologies allemandes basées presque exclusivement sur les techniques de combustion et qui semblent moins coûteuses que la technique de laveur de gaz utilisée aux États-Unis.

Le conférencier souligne de plus la nécessité de la coopération entre les Gouvernements pour combattre ce problème. Il présente la proposition qu'il parraine avec le gouverneur Dukakis au niveau fédéral américain pour briser l'impasse sur les précipitations acides. Il souhaite en terminant que les participants quittent la conférence avec la volonté politique de résoudre ce problème. (E)

ACID PRECIPITATION IN EUROPE: REPORT ON A SURVEY BY THE NATIONAL GOVERNORS' ASSOCIATION

Anthony S. Earl
Governor of Wisconsin

When people are struggling with a problem and cannot come to a resolution, it is often beneficial to do a little traveling, to go somewhere where somebody has grappled with the same problem and has come to a resolution. It was with exactly that thought in mind that several representatives of the National Governors' Association undertook a trip to West Germany in the fall of 1984. We had seen West Germany pass, in that year, some of the toughest controls on sulfur dioxide (SO_2) and nitrogen oxides (NO_x) emissions, therefore we knew that there was something afoot. West Germany, though an admirable nation in many ways, has never been considered as an environmental pace setter; hence we knew, when they moved from near inaction to very serious action in a short period of time that we ought to go and make a few observations.

We knew that was the case because in our country, as in yours, our debate on the question of acid rain, the damages it causes and the possible solutions to the problem, has long since been mired in regional differences and in various sides being polarized. The only thing we have all succeeded in is commissioning more studies. In the United States we have had five years of fruitless debate in our Congress on the question of acid rain.

But in 1984, in West Germany, the acid rain question with the extensive forest damage apparently related to it hit the top of the political agenda and laws were passed in the federal legislature to reduce SO_2 emissions by 60 percent and NO_x emissions by 40 percent by 1993. Two of the provinces passed laws that even went beyond these federal standards.

How had the Germans made such a breakthrough? Curiosity on that point would have been reason enough for us to investigate, and the German Marshall fund provided us with the wherewithal to make the trip. However, we wanted to examine other key issues as well.

For example, what exactly had happened to the forests? How had they declined? How did the political debate develop that led to such tough controls in a relatively short time? How did the West Germans deal with the very difficult issue of who pays for the clean-up? Finally, what new emission control technologies were the Germans utilizing that might have some potential for use here in North America? I think it is fair to say that our curiosity on these and a host of other subjects was satisfied by the time we had returned.

Let me share with you some of the highlights of what we learned. First and foremost, let me talk about the forests, because in West Germany, acid rain and forests are most intimately related. Moreover, because of the quasi-religious fervour the Germans have for their forests, they get a great deal of attention. Notwithstanding the importance of the forest in German mythology and religion however, forests are a major economic factor as well. It is certainly no coincidence that the movement to combat acid rain gathered momentum as public awareness of damage to forests grew.

It was clear that forest damage had increased dramatically in the last few years. During a meeting, the Minister of Forestry, who is from Bavaria and from the more conservative political party there, acknowledged that he had been very skeptical about the damage to forests, and in 1981, had ordered a formal survey of forests in Bavaria. That survey disclosed no visible damage.

In 1982 a wider study was undertaken. The federal government became involved, and damage to 8 percent of the nation's forest cover was observed. By 1983 that percentage had jumped to 34 percent and by 1984, the year of our visit, that percentage had reached 50 percent - 50 percent of the entire forest cover evidencing some kind of damage.

How had it come on so fast? Obviously it had not. It was only that the outward manifestations of the stress on the trees showed themselves so late. Visible damage was simply the final stage of a stress problem that had been building up for years. A look at core samples of damaged trees in the Black Forest, for example, showed that many of the trees had been growing relatively little each year for as long as ten to fifteen years and during that same period there had been some natural stress phenomena. For example, there had been a couple of years of extraordinary drought. With extreme temperatures, particularly extreme cold, for some years the trees were able to withstand the drought, afterwards however they could no longer. Thus, following the relatively dry year of 1983, and its hot summer, the trees began to show great damage. Every major tree species was touched, although most of the attention was focused on the spruce and the fir trees, with damages ranging from the loss of needles in some cases to the actual death of trees in many other cases.

What this meant to all of us, and we were a variety of points of view on this trip, was quite clear. By the time visible damage can be seen the battle is lost. Consequently, the strategy which ought to be undertaken (and indeed the strategy the Germans are undertaking now) is to try to protect the younger, less exposed stands of trees - tomorrow's trees. Hence, rather than waiting to see just how extensive this damage will be, acting on emission controls now is important to save tomorrow's trees.

It also seems to me to mean that we here in North America ought to do a better job than we have so far on developing an early warning system to identify forest decline. We have spent most of our attention of late on our water resource. We have heard a good deal today about taking a look at forest decline, but it seems to have been rather topical, one section of Ontario or Québec, one section of Vermont and one section of the Appalachian Mountains and the western Carolinas. Certainly, some early warning system that has credibility across the border ought to be developed, and there ought to be a common technique used for assessing visible forest damage.

In point of fact, one of the reasons the Germans are even now experiencing some difficulty in convincing people that they are sustaining such forest damage is that they used, until recently, a variety of different measurements to ascertain what the forest damage was. They have finally come up with a uniform system. Certainly it would make sense for us to develop a common technique for assessing forest damage, starting with visible forest damage.

Let me now turn to another issue. We were satisfied that there was forest damage, and that it was extensive. But what of the question of cause and effect. We talked to people in Great Britain, we talked to people in the European Economic Community in Brussels, and we visited with many people in Germany. Though they disagreed on many aspects of the acid rain question, the one thing on which they did agree was that air pollution, in its broadest sense, was a serious problem for forests, lakes and monuments.

The debate there was far broader than we had assumed and the focus was not nearly so close on acid rain or sulfur dioxide emissions. Rather, the debate was on sulfur dioxide, nitrogen oxides, hydrocarbons and the compounds that they can produce by interaction.

As a result, the strategy which has evolved in West Germany places a great deal of emphasis on the reduction of nitrogen oxides as well as on sulfur dioxides. I think that each of us who took the trip came back with the notion that the broader the strategy we devise to combat air pollution generally, the better we will do. It does not make a great deal of sense to wait until every last "t" is crossed or "i" dotted, as was suggested by the previous speaker, before we move ahead. The collection of data ought not be substituted for the making of policy judgments. We know that air pollution is detrimental to our natural resources or to human health. To try to further refine that argument before undertaking any action does not seem to be sensible. We know there are things we can do.

Let me mention a couple of other aspects of the debate that was going on in Germany. One had to do with mobile sources, automobiles. Frequently cited to us as proof that the Germans are serious about the acid rain problem was the debate they are now having about establishing speed limits. The Germans love their forests but they also love fast cars, and the hottest political debates that we were involved in during the trip were those debates over the efficacy of a speed limit on the Autobahn.

There is no debate in Germany however about the importance of emission control devices on automobiles. They have been moving in that direction, but they are slowed up by the fact that as members of the European Community they can only go as fast as the Community, and the Community is not willing to move as fast on emission controls for automobiles as the Germans would like. The French, the Bristish and the Italians manufacture automobiles and they do not want to move as rapidly as the Germans.

I must say, as a personal observation, that I sensed the argument was not strictly economic. I think there were some politics involved. I believe some of Germany's European neighbors felt that Germany had not expressed a great deal of enthusiasm for the environment in earlier years, and now that their ox was being gored they wanted to move very fast. Hence, some of the other Europeans might have been taking a bit slower attitude just to remind the Germans of their past practices. That is a strictly subjective observation, but it came through pretty clearly to me.

One question the Germans have resolved better than we is the question of cost sharing. Among the U.S. governors the one item that keeps us from coming to closer resolution of our point of view vis-à-vis our federal government is the issue of cost sharing. When the Germans began the debate, representatives from the coal producing and industrial areas had urged a national arrangement for paying for the costs. North-Rhine Westphalia is the main coal-producing area, and its representatives in the Bundestag proposed that all electric bills carry a surcharge equal to the cost of a forest planting, in that way everybody in Germany would pay. The proposal was hotly debated but defeated.

The West German government adopted the "polluter pays" principle, a familiar concept to us, but the implications of "polluter pays" in Germany are considerably different from "polluter pays" in the United States. That is because the utility grid in West Germany is largely interconnected, so any consumer of electricity from a coal-fired plant ultimately shares the costs of emission controls, whether that citizen lives in the Black Forest area or in the Ruhr valley.

We do not have such an interconnection in the U.S., or surely not much of one, and one of the observations made by members of our trip was that we would do well to focus more on interconnection between power

plants in the Midwest and the electricity network of New England and the northeast. Such a linkage would mean direct sharing of costs for acid rain controls without the need for a separate electricity tax or a national trust fund of some sort.

I know that representatives of the State of Ohio and representatives of the State of New Hampshire have had some informal talks about just such an arrangement. It seems to me to be attractive to both regions, both economically and environmentally.

In addition to learning about Germany's problems and its strategies, we also saw some impressive new technologies being used in the Federal Republic to reduce SO_2 and NO_x emissions. Those technologies focused almost exclusively on combustion techniques. The West Germans were paying little attention to scrubbers or stack devices; rather, the efforts were being made at finding better ways to burn coal more cleanly at the source.

We visited demonstration sites for fluidized bed combustion and we also saw limestone injections and a limestone injection multistage burner which had been developed at a commercial scale. These two technologies, it seemed to us, offered better gains at lower costs than scrubbers. Both of them can be economically coupled with coal washing and they appear very promising. We would like to see them tried out here in America. I know that there are some efforts underway, one with the "Tennessee Valley Authority" in Kentucky and one in Pennsylvania, but we are being very cautious in this direction compared to the West Germans.

It struck us that if we should adopt an acid rain proposal along the lines of many that have been introduced in the Congress, a proposal with a very tight time frame that locks us into scrubbers, we

will be making a mistake. I believe timing is important. The Germans emphasized that, though they might have dragged their feet for too long, there were some who thought that they were now moving too fast and bypassing some cost-effective technologies in their haste to demonstrate to the population that they were going to get something done no matter what the cost.

It is certainly a lesson from which we can learn. Those who are counseling more study, and I direct my remarks particularly at utility people, ought to know that if the worm turns, as it did in West Germany, they may find themselves stuck with going along with very expensive technology to try to get a quicker result, rather than being given the opportunity today to use some available technologies that may be considerably more cost-effective.

The final conclusion of our trip was that the ultimate resolution of this problem is going to involve a great deal of international cooperation. Our final stop was in Brussels at the European Economic Community. The political problems faced by Europeans in addressing this problem make ours pale. If Germany were to do everything it could to drop its emissions, it would only address, at best, 50 percent of its problem. At least half of the emissions in West Germany are inherited from the United Kingdom, from France, from the Netherlands and - even more difficult for West Germany - from East Germany and Czechoslovakia. A large effort has to be made to try to effect a cooperative attitude between these countries.

The problem certainly does not respect political borders. We know that. But our efforts here in North America at resolving this ought to be considerably easier. The United States, Canada, and increasingly, Mexico each contribute to one another's air pollution problems. It seems to me then that we must encourage a much more serious

effort at working jointly at resolving them. Quite frankly, I believe that our host this morning was very polite. Special envoys are fine, but we need a lot more than special envoys and much more than new studies. We need to embark on meaningful cooperative action and soon, the sooner the better. Accordingly, let me close by mentioning a proposal which evolved from our visit and which Governor Sununu and I asked our respective senators to introduce in Congress in order to break the federal deadlock on acid rain.

The bill we developed has a phased approach. It is ultimately two 5-million ton stages. The first phase stresses a great deal of flexibility. The second phase could be reviewed if, after the conclusion of the first phase, research that is now in progress indicated that the second-phase pollution reduction ought not be that large, or perhaps, ought to extend over a longer period of time.

It is a proposal based on "polluter pays". I think all of us would like to have our friends in the West pay a share of the cost emission controls, but states west of the Mississippi contribute only about 10 percent of the problem and it is, frankly, unrealistic at this time to try to get them to pay for a problem the resolution of which will benefit principally the Midwest, the New England states and, increasingly, the southeastern states.

It is a bill which puts a very real premium on new technology and tries to avoid locking us into a scrubber technology. The bill has an emphasis on both SO_2 and NO_x controls. I have had an opportunity to visit with people about the bill and I understand it will be marked up for consideration on the floor of the Senate by June, 1985. I hope that it begins some momentum toward resolution of this problem.

Unfortunately, it took great damage to a treasured national resource to move the Germans to action. I hope that we can learn from their unhappy experience and get on with the task of resolving this serious problem. There is certainly no shortage of studies. If there is a shortage of anything in this debate, it is a shortage of the political will necessary to resolve the problem. I hope that in addition to our reviewing the scientific studies, we can leave this meeting with the political will to begin resolving the acid rain problem and begin now.

BIOGRAPHY

Governor Anthony S. Earl was elected in the general election of 1982 and was inaugurated as the 40th governor of Wisconsin in January of 1983. Previously he served as the Secretary of Wisconsin's Department of Natural Resources (1975-1980) and also as Secretary of Wisconsin's Department of Administration (1974) and in the state legislature as majority leader of the Assembly (1971-1975).

On his first year as Governor he was named Chairman of the newly formed Council of Great Lakes Governors. In 1984, he was named Chairman of the Standing Committee on Energy and the Environment of the National Governors' Association.

THE EUROPEAN COMMUNITY: ACTIONS TO CONTROL ACID DEPOSITION

Jan Smeets
Division pour la prévention et le contrôle
de la pollution
Communauté économique européenne

RÉSUMÉ

Jan Smeets présente les activités mises de l'avant par la Communauté économique européenne pour combattre la pollution de l'air qui menace la forêt européenne. La Communauté économique européenne (CEE) a préparé, en novembre 1983, un programme d'action qui vient renforcer la législation environnementale de la Communauté dans le domaine de la pollution de l'air. Ce programme qui réfère particulièrement aux précipitations acides propose de nouvelles normes pour le contenu maximum en soufre des huiles (gaz-oil). Des discussions sont également en cours pour fixer le contenu maximum en soufre du mazout et du charbon ainsi que pour réduire les émissions de polluants provenant de la combustion des huiles usées.

Le CEE propose également une réduction substantielle de l'anhydride sulfureux et des oxydes d'azote pour les usines à forte consommation de combustibles. Des limites d'émissions sont également proposées pour les nouvelles usines de ce type. Un autre aspect du programme touche la fixation de normes d'émissions pour les véhicules moteurs.

On vise ainsi à atteindre, d'ici 1995, pour l'ensemble de la Communauté européenne, une réduction globale de 1980, de 60 pour cent des émissions d'anhydride sulfureux, de 40 pour cent des émissions de poussière et de 40 pour cent des émissions d'oxydes d'azote par rapport aux données de 1980.

Enfin, Jan Smeets évalue les dommages causés par les émissions de SO_2 et de NO_x pour la CEE à un montant qui se situe entre 1,4 et 4,2 milliards de dollars U.S. (E)

THE EUROPEAN COMMUNITY: ACTIONS TO CONTROL ACID DEPOSITION

Jan Smeets
Division pour la prévention et le contrôle
de la pollution
Commission économique européenne

Monsieur le Président, Monsieur le Ministre, Mesdames et Messieurs. C'est pour moi un grand honneur et un grand plaisir de présenter un résumé des activités de la Communauté économique européenne dans le domaine de la lutte contre les pluies acides. Cette conférence revêt une importance, qui, pour plusieurs raisons, dépasse de loin la dimension d'une conférence à caractère régional et je remercie les organisateurs de me donner la possibilité d'être avec vous. Je regrette que Sir Hugh Rossi n'ait pu venir. Les organisateurs m'ont demandé seulement hier soir de le remplacer et de vous informer sur les activités de la Communauté économique européenne.

Je m'excuse si ma présentation n'est pas aussi complète que je l'aurais souhaité puisque, comme vous le comprenez, je n'ai pas eu le temps de me préparer d'une façon adéquate.

Let me first explain in a very few words - for a better understanding of the decision making - the procedures and responsibilities inside the European Community. As you know, this Community is now a Community of ten Member States; however, as you might have recently learned, starting January 1st 1986, Spain and Portugal will join its ranks. The seat is in Brussels, with the Commission as the administrative institution and executive, and is supervised and controlled by the Council of Minister, the European Parliament, the Social and Economic Committee, and the Court of Justice.

The Commission, which is in a certain sense comparable with a conglomerate of ministries, takes initiatives amongst others to prepare legislative proposals, such as directives, regulations, decisions and so on. The proposed legislative measures become legislations in the whole Community after adoption by the Council of Ministers. This means, that these decisions have to be transferred in the national legislations of the ten Member States. These Community measures are not recommendations, but legislations. This should be taken into account before I go in more detail on the subject matter of this conference.

I thank the Governor of Wisconsin for the information he has just given on ongoing matters in this area in the Federal Republic of West Germany.

One of the interesting aspects of our work in the European Community, and particularly in the Commission, is amongst others the harmonization of legislations in Member States. This harmonization should avoid the creation of technical barriers to trade inside the European Community. Some of the proposals and legislations the Governor of Wisconsin has talked about are part of the ongoing work in the European Community.

The European Council meeting of the Heads of States in Stuttgart in 1983 was a very important one for the environment, since at that time the ten Heads of States led a very strong political move for action in the field of combatting air pollution. They proclaimed the urgent necessity of accelerating and reinforcing action at national, community and international level, particularly aimed at combatting air pollution. They emphasized the acute danger threatening the European forest areas; they did a strong call for immediate action to avoid an irreversible situation.

As a follow-up, the Commission organized in September 1983 a colloquium on "Acid Deposition: A Challenge for Europe". This symposium reported on the current state of our knowledge on the origin, transport, conversion and deposition of air pollutants, on the effects of air pollutants and acid depositions, on the emission reduction strategies and on the ecological effects of sulfur and nitrogen compound depositions and other related substances.

As the next step after this symposium an important action program was launched in November, 1983, to reinforce existing Community and environmental legislation to combat air pollution. I should stress, that there are already environmental action programs going on on a community level since 1972, but this new program emphasized particular air pollution issues which should be considered by priority.

In the past thirteen years the Commission has proposed three types of measures in this area, which have been adopted by the Council of Ministers:

- air quality standards relating to sulfur dioxide, suspended particulate matter, lead and nitrogen dioxide, binding all the Community;

- emission control standards relating to vehicle exhaust gases;

- product control standards such as limiting the sulfur content in gas oil and the lead content in petrol.

The more recent action program with respect to acid deposition concerns five particular points. The first one is a proposal for a directive controling the emissions from large combustion plants. I will

come back to this proposal in more detail in a few minutes. The Governor of Wisconsin has already referred to it when he was talking about the Federal Republic of Germany.

Recently, the Commission submitted to the Council of Ministers a proposal for a directive to reduce in a significant way the sulfur content of gas oil. Already in 1975 such a directive had been adopted by the Council of Ministers, but a further reduction is now proposed. The maximum sulfur content in gas oil should not exceed 0.3 percent starting July 1st, 1987. The discussions in the Council of Ministers on this proposal will start shortly.

Seven or eight years ago, the Commission submitted to the Council a proposal for a directive dealing with the sulfur content in heavy fuel oils. We envisaged at that time to reduce the sulfur content and the sulfur emissions for this product. However, during the negotiations with the Member States we had quite a lot of problems in the Council of Ministers. Some of the countries felt we should not limit ourselves to heavy fuel oils only, but that the sulfur content of coal should be considered as well. In effect, the Commission finally had to withdraw its proposal in 1981. Now, we are preparing a new proposal dealing with the maximum sulfur content in fuel oils as well as in coal.

Someday, we shall submit a proposal reducing the emissions of pollutants coming from the burning of used oils. It will be conceived to reduce the emissions of sulfur dioxide and nitrogen oxides, and of toxic and dangerous substances such as heavy metals as well as to promote the recycling of used oils.

Last year, the Commission made proposals for a comprehensive package of measures to reduce emissions from motor vehicles. The Governor of Wisconsin has already referred to it and I will go in more detail on this particular matter later during this presentation.

In this context, I might inform you that the Council of Ministers adopted in December of last year a directive introducing lead-free petrol on the Community market, starting October 1st, 1989. Lead-free petrol must be available at the latest at that date. Countries that wish to introduce it earlier may do so freely; several companies are already delivering lead-free petrol.

Let me come back a few minutes to our proposal dealing with the emissions from large combustion plants, proposal which we consider as a very important issue. The emission of pollutants such as sulfur dioxide and nitrogen oxides from large combustion plants is considered a main source of air pollution and the main precursor of acid deposition. Therefore, as a matter of priority, the Commission intends to tackle pollution caused by combustion plants and by these pollutants by proposing a substantial reduction of emissions of sulfur dioxide, nitrogen oxides and particulates from large combustion plants over 50 thermal megawatts. Emission limit values are proposed for new plants based on the best available technology and type of combustion plant concerned. The best available technology should have proved to be reliable on an industrial scale and should not add disproportionate costs.

The global reduction of emissions is considered by applying measures at the same time for existing plants as well as to new ones. In seeking to achieve the objectives of limiting and reducing emissions, it is essential to take full account of the complexity and the variety of the situation of the different parameters in the ten individual Member States and to respect as far as possible the different national approaches. The Commission's proposal, therefore, includes an overall emission reduction target which would apply to the totality of large combustion plants, both existing ones and new ones. These targets would allow the Member States in a certain limit to decide on the mix of measures which are best suited to the particular circumstances, while

still retaining for the Community certainty of the magnitude and the time scale of the reduction to be achieved.

The targets which the Commission has proposed would aim for the reduction in emission from large plants - taking as a basis the annual mean levels of emissions recorded in 1980 - at the end of 1995 as a time limit for achievement. We have proposed a 60 percent reduction for sulfur dioxide - the figure mentioned already by the Governor of Wisconsin for the Federal Republic of West Germany - 40 percent for dusts and 40 percent for nitrogen oxides.

Let me say in this context, that I was somewhat surprised this morning to hear the figures about emissions here in the United States and in Canada. I learned that in the United States in 1980 the emissions were in the order of 24 to 25 million tonnes of SO_2 per year with a population of about 240 million; in Canada the figures mentioned were 5,4 million tonnes for about 24 million inhabitants. The European Community has an estimated emission level of about 15 million tonnes of SO_2 with a population of about 280 million inhabitants; therefore I think the situation in our countries is somewhat more favourable than in northern America, particularly if you calculate the pro capita emissions.

Coming back to the implementation of the proposed directive, we are aware that it will require a considerable financial, technical and engineering effort even where the technologies are already available. Significant lead times will be involved and careful planning will be essential. One of the major problems will be the retrofitting of existing plants.

The reduction of NO_x emissions from large combustion plants, which are likely to be less costly than the reduction of SO_2 emissions,

also poses considerable technological problems with several years of development work still to be needed.

We have been discussing this proposal on the level of the Council of Ministers for more than a year; I might assure you, Mr. Chairman, that there are still quite a lot of problems to be solved to get our proposal adopted and hopefully without too many modifications and compromises.

Another issue in which you might be interested, and to which the Governor of Wisconsin has already referred to, concerns the establishment of standards for car exhaust gases. After very, very long discussions, a first series of proposals has recently been adopted by the Council of Ministers. They are only the beginning of the decision making process in this area.

The length and nature of negotiations demonstrate very well the different interests of the Member States in Commission proposals with great industrial, economic and social impact.

It is not confidential information when I tell you that there are great and essential differences not only between the car industry but also in driving habits, socio-economic aspects, etc., in our Member States. Particularly, the protection of the national automobile industries plays an important role in the discussions and negociations.

There was a general policy from the beginning that the Community should not tackle the whole problem by imposing catalytic convertors for all cars, since the cost of such convertors is very important and prohibitive for smaller cars. During the first round of negotiations, the Ministers agreed that measures and standards should be considered for three different classes of cars.

The first class, is the larger than 2,000 cc category. For those cars, European standards, which are more or less equivalent to the American standards, should be adopted for the new models and be enforced as of October 1st, 1988; while for new cars of existing models, the standard should be adopted and enforced October 1st, 1989.

The second class of cars is between 1.4 and 2 litres. New models should follow the European standards, again equivalent to the American standards, to be introduced for the new models in 1991 and for new cars of existing models in 1993.

The cars belonging to the third category, less than 1.4 litres, will have to comply at later dates (1993 and 1994), and with less stringent levels than in the United States.

The Commission is now translating the American standards, using the American test cycle, into European standards with the completely different European test cycle. We were very happy that this fundamental proposal was adopted as an initial step. Now, we are anxious to learn the outcome of the Council of Ministers at the end of June concerning precise figures for the standards and the three categories of cars.

Mr. Chairman, I should have mentioned to you, before I gave this more detailed presentation on control measures that the Commission has also been studying for some time the economic aspects of the damage caused by SO_2 and NO_x emissions.

I will put figures together in order not to submerge you in too many data, but it is estimated, that the yearly damage in the European Community is between 1.4 and 4.2 billion in U.S. dollars, taking into account corrosion of materials and buildings, loss of

agricultural yield, loss of forest yield, damage to public health, loss of revenue from tourism, fishing and so on.

No figure has been included for the unquantifiable damage and impact of acid rain to historic monuments, for example, which are very important in Europe. The figure which we used for the damage to public health is really minimal and based on OECD data. Induced damage to human health could be a major cost item and as much as 1.2 to 1.6 U.S. dollars per inhabitant.

Taking all those points into account, the real cost of the damage could well be higher than the cost of all the emission reduction measures proposed.

Mr. Chairman, I have a last point to mention to you, which we also consider as a very important issue and which has not been mentioned today. This is the Geneva convention on long-range transboundary air pollution. You are all aware of the negotiations going on in Geneva and that a protocol should be adopted by all those who have signed this convention. This protocol aims for a 30 percent reduction in air pollution in the coming years until 1993. We, from the Commission, are very much interested in this protocol and we hope that most of the countries which have signed the convention will adhere to it.

Mr. Chairman, Ladies and Gentlemen, I have given a general overview of our main current activities. Since I am replacing Sir Hugh Rossi, and since I recently had the pleasure of being with him at another conference, I should like to refer to some of his recent quotations. In my opinion they are also of political interest for this meeting. In fact, he had been in discussion with the most important English utility organization producing energy, i.e. the CEGB, when it mentioned the high cost involved in adopting proposals such as those to

which I have referred. And the costs would go up a lot more. Mr. Rossi's answer was that, although electricity costs would undoubtedly rise, they would do so at less than 1 percent per annum to carry out desulfurization. To his knowledge there had not been a time when electricity costs went up less than 1 percent per annum. Actually, they had increased considerably more under the financial regime followed by the CEGB. Futhermore, Mr. Rossi told the CEGB that the great and good British public would far prefer to see an increase in the price of electricity in order to meet a dangerous problem of this kind than some of the other reasons for which electricity charges had been going up recently.

He added another part to this statement, which I also think is of interest. As only some 60 members of parliament turned up on a Friday morning to debate this particular issue of acid rain, compared to the more than 300 parliamentarians showing up on another Friday to discuss whether or not experimentation should take place on a human embryo fertilized in vitro, he commented that this difference was simply due to public awareness, public alarm, public insistance, public pressure upon the members of the parliament.

Mr. Chairman, I think these statements represent some of the thinking in this area in some of our European countries.

In view of the available time, I have limited my presentation to the main activities of the European Community leading to a reduction in acid depositions. I did not inform you about the less operational but no less important aspects such as our ongoing research and research programs, the Communities' work in the field of energy, the protection of the important cultural heritage, the abatement technologies or the clean technologies which we are trying to develop, the Communities' monitoring programs with respect to the health of men and forests, etc.

However, I believe I have given you a general survey of our legislative engagements to which ten Member States endeavour to devote themselves; engagements important from the environmental as well as from the political and socioeconomic point of view.

BIOGRAPHY

Jan Smeets is the head of the Division for the Prevention and the Control of the Pollution for the Commission of the European Communities. He studied forestry at the University of Groningen in the Netherlands, and he has had substantial training and completed post-graduate studies in nuclear hygiene, as well as in environmental radioactive contamination. His Doctor's thesis was in the general subject of ecology. He joined the European Community in 1962 as head of the division.

FINDINGS AND CONCLUSIONS OF THE U.S. AND CANADIAN PEER REVIEWS PANELS ON U.S./CANADA MEMORANDUM OF INTENT ON TRANSBOUNDARY AIR POLLUTION REPORTS

Hans C. Martin
LRTAP Liaison Office
Environment Canada

RÉSUMÉ

Hans C. Martin présente les conclusions de l'évaluation par des pairs américains et canadiens des rapports techniques produits à la suite du Mémoire d'intention sur la pollution transfrontalière signé entre les gouvernements du Canada et des États-Unis en août 1980. Les deux Comités conviennent qu'une grande partie de l'est de l'Amérique du Nord est agressée par les précipitations acides. Les dépôts acides annuels sont au moins dix fois plus élevés que les dépôts que l'on retrouve dans les régions éloignées. Les écosystèmes aquatiques sont sévèrement affectés et les dommages les plus significatifs sont constatés en milieux sensibles. Les plus forts dépôts acides sont retrouvés près des régions émettrices. Le chaulage n'est qu'une solution temporaire et la réduction des émissions apparaît comme la seule voie pour arrêter les dommages observés dans les lacs et les rivières.

Par ailleurs, les conclusions des deux Comités diffèrent sur les effets terrestres des précipitations acides, l'utilisation des modèles mathématiques de transport à grande distance des polluants atmosphériques et sur un objectif annuel de dépôts acides. Le groupe de travail canadien préconise sur ce dernier point un objectif environnemental de 20 kilogrammes par hectare par année pour assurer la protection des écosystèmes aquatiques modérément sensibles tandis que le groupe de travail américain n'en retient aucun. (E)

FINDINGS AND CONCLUSIONS OF THE U.S. AND CANADIAN PEER REVIEWS PANELS ON U.S./CANADA MEMORANDUM OF INTENT ON TRANSBOUNDARY AIR POLLUTION REPORTS

Hans C. Martin
Environment Canada

Introduction

This presentation is a sort of history lesson for several reasons: the Work Group reports were released in 1983; they do not include research results published in the last three years; and finally, the peer panels completed their work at least one year ago. Nevertheless, there is merit in examining both the Work Groups documents and the Peer Reviews, if only to discuss these two difficult projects which have been to some degree ignored.

My discussion will be in four parts:

A) the MOI assignment
B) the Peer Review panels
C) general findings and conclusions of the Peer Reviews
D) specific findings and conclusions of the Peer Reviews

The MOI Assignment

The Memorandum of Intent Between the Governement of Canada and the Governement of the United States of America Concerning Transboundary Air Pollution was signed in August 1980. Among other things, it instructed that: both governments take all necessary steps forthwith to provide necessary resources for the coordinating committee to carry out its work, including the working group structure. This instruction

launched the workgroup task of producing a state of the art review of most of the components of the acid rain issue. There were five working groups in all. I will discuss the reports produced by three of the Work Groups: a) Effects, b) Atmospheric Sciences c) Emissions, Costs and Engineering Technology for Controls. The working groups on Strategies Development, and Legal and Institutional Arrangements did not produce final reports.

The Work Groups commenced in the fall of 1980 immediately after the signing of the memorandum. Their work was completed in the spring of 1983, two and a half years later. During the two and a half years they produced several interim reports. There were three final documents with an additional four attachments to the Atmospheric Sciences report. The 1,687 pages were written by 160 authors with acknowledgements being made to 83 additional scientific authorities throughout the world.

The Peer Review Panels

Initially it was thought that the peer review might be undertaken by a single body on behalf of the two governments. In the end each government struck a peer panel of its own.

In 1982 the Canadian government asked the Royal Society of Canada to undertake a peer review of the MOI documents. The Royal Society asked Dr. Ken Hare, provost of Trinity College, University of Toronto, to chair the peer panel and to draw together the necessary members. The panel was composed of 3 scientists from the United States, 3 from Europe, and 10 from Canada.

The Terms of Reference for the panel were:

a) to determine whether all significant data had been taken into account,
b) to determine whether judgments were balanced,
c) to determine whether uncertainties in science had been treated fully,
d) to make recommendations on research gaps.

The panel delivered its final report to the Royal Society in May 1983, that is, two years ago. The Royal Society in turn transmitted the report to Environment Canada as recipient for the Government of Canada. This is one of the documents I will discuss shortly.

In the United States Dr. George A. Keyworth II, Director, Office of Science and Technology Policy and Science Advisor to the President, appointed Dr. William Nierenberg, Director of the Scripps Institute of Oceanography as chairman of a panel and asked him to assemble the necessary panel members. This was done in January, 1982. There were 9 panel members, all from universities and scientific institutes in the United States.

The Terms of Reference of the panel were:

a) to determine whether the work groups had taken account of available knowledge,
b) to determine whether the work groups had fulfilled their charter,
c) to determine whether the work groups had used all significant information while identifying assumptions, discussion alternatives, providing support for conclusions, and addressing uncertainty,

d) to provide an independent assessment of uncertainty,
e) to make recommendations on future research.

The panel delivered its final report in July 1984, approximately one year ago. This is the other document discussed in the following sections.

You will note that the panels are rather similar in composition and size. In addition, their Terms of Reference are similar and both bodies commenced work one year prior to the completion of all the work group reports, since they were able to use interim work group reports.

General Findings and Conclusions of the Panels

Before proceeding, a word of explanation is in order as to how I dealt with the panel reports. I carefully examined each of the two peer reports and noted statements which made concise observations on the quality of the workgroup reports themselves or made a clear statement on the acid rain issue, as perceived by the peers. I then exercised some judgment in choosing points which had significant bearing on the present discussion. Most of what follows is quoted material. The superscript numbers and the appendix at the end identify the panel report which made the statement.* I have taken great care to avoid misleading statements which might arise as a consequence of taking words out of context. In some cases the statements here have been slightly edited in order to improve continuity. The content is not changed. In three areas the panels had different opinions and these are fully explored below.

* The attribution of material drawn from the peer reports was not given at the Quebec Conference but is included here in the appendix.

Overall, both peer panels praised the work groups for producing a synthesis which was a commendable effort. Specific comments follow:

1. The synthesis and integration was not adequate.[1]

2. The search for consensus made the reports cautious and conservative in tone.[2] Critical issues were hedged.[3]

3. Our knowledge of the effects of acid rain is incomplete.[4] There emerges a picture of uncertainty.[5]

   - The best assessment is presented for effects on rivers and lakes.[6]
   - The assessment of effects on forests/soil is not as comprehensive.[7] Vigilance in this component of the ecosystem is urged.[8]

4. The report by the atmospheric group was well done[9] and creditable.[10]

5. The report on emissions and control technology was considered an indispensable but very tedious sourcebook.[11]

6. There was an overwhelming preference given to the question of acidic deposition[12] in particular SO_2.[13] Other pollutants were not treated adequately. This was a weakness.

7. There was little discussion of the deposition of pollutants in dry form that is as gases or particles - so called 'dry deposition'. This was a weakness.

8. The discussion of the economic benefit of control was of limited value.[14] Perhaps the panels over-optimistically expected a cost and benefit analysis.[15] There was a complete lack of a framework to access the benefits of emission control.[16] No efficient management strategy for the containment of acid deposition emerged.[17]

   These comments critique the scope and depth of the reports.

Specific Findings and Conclusions of the Panels

I would like now to turn to specific findings and conclusions of the panels. These statements will largely focus on the nature of the problem.

The two panels agreed on the following:

1. Large portions of eastern North America are stressed by wet and dry deposition of acid forming substances.[18] Acid precipitation affects all areas roughly east of the Mississippi and south of a line through central Ontario and Québec.[19]

3. Annual depositions of acidity are at least ten times greater than depositions in remote areas.[22] In some cases depositions are one hundred times higher than expected.[23]

4. The evidence is convincing - something is happening.[24] Aquatic systems are clearly affected.[25] Acid deposition has altered their chemistry and biological character.[26]

5. Fish populations are being stressed.[27] Changes often include the disappearance of fish.[28]

6. The largest effects are in sensitive areas.[29] Highly significant damage to sensitive lakes and streams is confirmed.[30] Large areas of eastern North America are sensitive.[31]

7. The greatest sulphate deposition lies over and immediately downwind from regions of maximum sulphur emissions.[32] Areas receiving the most acid rain are found within or close to the major source regions.[33]

8. The proper approach is to begin immediately with the most economically effective steps for reducing acid deposition, including intensified coal washing and initial controls on nonferrous smelters.[34] Reductions of emissions is the only way to stop the observed damage to lakes and streams.[35]

9. The treatment of lakes through liming is a temporary solution to be used as sparingly as possible.[36]

This list of agreed statements is not complete. I have tried to select the key points while passing by the subordinate more detailed points of agreement. I would now like to present three additional points. Agreement here was not complete or there was disagreement. I will start with the least contentious point.

A. Forest/soil effects

The U.S. panel concluded:

- Terrestrial effects may be very important.
- Forest damage is increasing in eastern North America.

- Acid deposition may be a contributor.
- There is a grave prospect that changes may occur in microorganic communities in soils.

The Canadian panel concluded:

- Forest impacts are less conclusive.
- No significant damage due to long range air pollutants has been demonstrated in Canadian forests.

I think we have here a difference in emphasis. There may be several reasons for this difference.

I should add that the Canadian panel noted that the European debate was ignored and that specific analysis of this question of forest effects must be undertaken in North American forests.

The American panel reviewed a number of reports on the damage which has occurred in the forests of the Federal Republic of Germany. A list of papers is given in their appendix.

B. The second point of difference concerns computer models of the atmosphere. There is a difference of opinion here.

The American panel concluded:

- The Work Group overemphasized the role of models.
- The performance of the models is still marginal. Their value is still limited.
- The reports make it abundantly clear that the models failed to furnish reliable source-receptor relationships.

The Canadian Panel cooncluded:

- The models are unreliable.
- Although the oversimplified chemistry used in the models is not important for long time scales and large areas, the panel expressed frustration because no test of model results were made using field data.

The Canadian panel did not drop the matter there but went on to say:

- A key element in devising an abatement strategy will be the modelling of the transport, chemical transformation and deposition of acidifying or toxic substances by the atmosphere.

- The models available at the time when the reports were written were not adequate and had not been tested against observations.

- Work done since then in Canada confirms that the models can be improved sufficiently to put them to use in an abatement strategy.

C. The third point of difference is the most important one and concerns the target loading debate.

A brief comment is in order concerning the purpose of a target loading. The question to be asked is "What is the maximum quantity of pollution that can fall on a lake or river or tree without causing injury?". This maximum quantity becomes a target to be achieved in areas where more than this amount of pollution is being deposited and

where there is, therefore, injury. The Effects Work Group thought there was hope for developing a target for surface waters. They decided that sulphate in precipitation would be the appropriate pollutant. During their discussions, the Work Group agreed on the three findings and the panels accepted the findings:

> In sensitive fresh-waters no chemical or biological effects are observed when sulphate loadings from rain are less than 17 kilogrammes per hectare per year (kg/ha/yr).[37]
>
> Chemical effects begin to be observed at loadings between 20 and 30 kg/ha/yr respectively.[38]
>
> Above 30 kg/ha/yr both chemical and biological effects are experienced in some sensitive surface waters.[39]

This was the point of departure in the Work Group reports. In two separate statements:

- the Canadians presented a target of 20 kg/ha/yr,
- the Americans presented no target.

This is the only place in the 1687 pages where concensus was not reached.

The response of the review panel was the following:

Dr. Nierenberg's Panel:

- the greatest failing of the Work Group document is the lack of an agreed deposition rate,

- a target loading should be set and it is recommended that the Work Group reconvene.

The U.S. panel then made the proposal that if the figures given in the reports are used:

- it would follow that a decrease to 30 kg/ha/yr would serve to eliminate damage to all but the most delicate of the fresh water biological ecosystems.

Dr. Hare's Panel

- agreed that the Canadian target of 20 kg followed naturally from the agreed text of the Work Group.

The Canadian panel then went on to say that:

- it could not reconcile the U.S. conclusions with the agreed text,

- the 20 kg/ha/yr target proposed by the Canadian Work Group members is on the lax side - it is not low enough.

The target is of critical importance because:

- it identifies where you want to go with a program for sulphur reductions,

- you can measure the value in the field with good accuracy,

- if you are above the target, you have to reduce sulphur deposition.

The target loading becomes the focus of the control program and is a critical benchmark by which we can judge the success of any control program.

The issue rests there.

Conclusion

In closing, I would like to present a statement drawn from the Peer panel reports which characterizes their views of the problem and its solution.

'We recommend that additional steps should be taken now which will result in meaningful reductions in the emissions of sulphur and nitrogen compounds into the atmosphere, beginning with those steps which are most cost-effective in reducing total deposition.[40] Emission reductions are meaningful when they produce a detectable decrease in both acidic deposition and degradation of the biosphere.[41] Given (i) the substantial evidence and argument assembled by the Work Groups, (ii) the remarkable similarities between North American and Scandinavian experience, and (iii) the probability that further damage is in progress now, and will continue, the panel urges that an abatement strategy be adopted as soon as possible.[42]

Any current scientifically derived recommendation must be based on an imperfect, but always increasing, body of pertinent data whose quality and completeness can be expected to improve for decades.[43] Recommendations based on imperfect data run the risk of being in error; recommendations for inaction pending collection of all the desirable data entail the even greater risk of ecological damage.[44] In spite of the caution with which the reports draw conclusions, there is no doubt that the long-range transport of air pollutants calls for prompt action by the two governments.[45]

The benefits of a properly functioning ecosystem are more than matter of dollars and cents, and are often not appreciated by people unfamiliar with ecology.[46]

Seven sentences, five from the U.S. panel and two from the Canadian. I think this is a noteworthy statement. One has difficulty identifying the sources, that is, either the Canadian or American panel. The statement should not come as a surprise however, since scientists, acting as scientists, usally come to roughly the same conclusions when analyzing and judging a given set of results or observations.

APPENDIX

1.	U.S.	24.	U.S.
2.	Canada	25.	Canada
3.	U.S.	26.	U.S.
4.	U.S.	27.	Canada
5.	Canada	28.	U.S.
6.	U.S.	29.	U.S.
7.	U.S.	30.	Canada
8.	Canada	31.	U.S.
9.	Canada	32.	Canada
10.	U.S.	33.	U.S.
11.	Canada	34.	U.S.
12.	Canada	35.	Canada
13.	U.S.	36.	U.S.
14.	U.S.	37.	Canada
15.	Canada	38.	U.S.
16.	U.S.	39.	Canada
17.	Canada	40.	U.S.
18.	U.S.	41.	U.S.
19.	Canada	42.	Canada
20.	Canada	43.	U.S.
21.	U.S.	44.	U.S.
22.	U.S.	45.	Canada
23.	Canada	46.	U.S.

MATERIAL CITED

1. Impact Assessment, Work Group 1, United States - Canada Memorandum of Intent on Transboundary Air Pollution; Final Report, January 1983.

2. Atmospheric Sciences and Analysis Work Group 2, United States - Canada Memorandum of Intent on Transboundary Air Pollution; Final Report, November, 1982.

3. Emissions, Costs and Engineering Assessment Work Group 3B, United States - Canada Memorandum of Intent on Transboundary Air Pollution; Final Report, June 1982.

4. "Acid Deposition in North America - a review of the documents prepared under the Memorandum of Intent between Canada and the United States of America, 1980, on transboundary air pollution." Chairman's Appraisal, Royal Society of Canada, pp 20 Ottawa, May 1983.

5. Report of the Acid Rain Peer Review Panel, prepared for Dr. George A. Keyworth, II, Science Advisor to the President, (approx. pp, 90), Washington July 1984.

BIOGRAPHY

Dr. Hans C. Martin received his BSc at the University of Manitoba, his MSc and Ph.D. in Physics at the University of Western Ontario. His thesis was concerned with the turbulent structure of temperature and humidity near the surface. From 1966 to 1969, Dr. Martin worked as a Research Scientist in Australia continuing research on the exchange of heat and water vapour at the earth's surface. In 1969 he joined Environment Canada, Toronto, in their atmospheric research laboratories. After 1975 Dr. Martin held several management positions in government and private industry.

Since 1978 he has been involved in the LRTAP Technical program and is presently the Senior Advisor to the Federal "Acid Rain" program.

SCIENTIFIC, ECONOMIC AND POLITICAL IMPLICATIONS OF ACID RAIN CONTROL STRATEGIES

Anthony D. Cortese
Director
Center for Environmental Management
Tufts University

RÉSUMÉ

Au cours des dernières années, les effets néfastes causés par le déplacement sur de grandes distances des émissions de polluants atmosphériques, émissions résultant en précipitations acides, ont soulevé une vive controverse au Canada et aux États-Unis quant au choix des stratégies pour contrôler ces émissions. Dans l'est du continent nord-américain, on tente surtout de réduire les émissions d'oxydes de soufre provenant des services publics d'électricité et des grands complexes industriels parce que ce sont elles qui contribuent le plus à la formation de l'acide dans l'atmosphère. Les émissions d'oxydes d'azote, qui proviennent principalement des véhicules et des services publics d'électricité, contribuent également à ce phénomène. Face à cette situation, le gouvernement canadien avait lancé un appel pour que soient réduites de moitié, vers 1975, les émissions d'oxydes de soufre, au Canada et aux États-Unis. Par la suite, le Congrès américain et l'Agence de protection de l'environnement des États-Unis ont accéléré leurs travaux et élargi leur programme de recherche sur les précipitations acides. Ils ont également étudié divers projets de loi visant à contrôler les émissions d'oxydes de soufre et d'oxydes d'azote. En dépit de leurs efforts, les États-Unis n'ont pas encore réussi à légiférer en cette matière à cause de l'impossibilité d'arriver à un consensus sur les aspects scientifiques, économiques et politiques qui entourent le programme de réduction des précipitations acides.

La plus grande difficulté à laquelle se heurte l'établissement d'un consensus sur le programme de réduction des précipitations acides réside dans la définition de la ressource naturelle qui est le plus en péril. Si l'on décide, par exemple, d'axer le programme sur la protection des écosystèmes aquatiques, qui sont tellement fragiles, il faudra, logiquement, chercher à réduire les émissions d'oxydes de soufre. Par contre, si l'on vise à protéger les forêts, il faudra plutôt éliminer les émissions d'oxydes d'azote puisqu'elles contribuent aux précipitations acides et aux réactions photochimiques qui produisent l'ozone, cet agent pathogène qui agit sur les plantes. De toute manière, on admet généralement qu'en réduisant les émissions d'oxydes de soufre et d'oxydes d'azote, on peut réussir à atténuer les dangers auxquels sont exposés les êtres humains, les cours d'eau, la flore, les matériaux, les édifices historiques, les artefacts et l'atmosphère elle-même. Malheureusement, pour un grand nombre de Canadiens et d'Américains, ces dangers ne sont pas encore assez graves pour justifier une nouvelle réduction de la pollution atmosphérique.

Les scientifiques eux-mêmes ne connaissent pas encore avec certitude les effets comparatifs des précipitations sèches ou sous forme de pluie de composés acidifiants, ni le taux d'acidification des lacs, non plus que sa nature exacte, ni le rapport entre les sources d'émissions et les précipitations acides. Il est donc difficile de prendre des décisions quant aux sources d'émissions qu'il faudrait contrôler, à l'ampleur des réductions souhaitables et au meilleur moment de le faire. Jusqu'à maintenant, les propositions américaines ont porté principalement sur la réduction des émissions d'oxydes de soufre provenant des centrales électriques de l'est des États-Unis, qui sont alimentées au charbon, car elles produisent à elles seules environ 70 pour cent de toutes les émissions d'oxydes de soufre dans ce pays. Depuis peu, cependant, l'accent est mis sur les centrales électriques du centre des États-Unis, qui devraient assumer la plus grande part des réductions

en raison de leurs abondantes émissions de polluants. En outre, leurs longues cheminées rejettent ces émissions si haut dans l'atmosphère qu'elles sont transportées par les vents dominants à des centaines de milles plus loin, au-dessus des régions vulnérables du Canada et du nord-est des États-Unis. D'autre part, la présence de sources d'émissions d'oxydes de soufre dans ces mêmes régions fait qu'il est difficile de démontrer que c'est ainsi qu'on garantirait le mieux la protection des zones les plus fragiles.

La mise en oeuvre des programmes de réduction des émissions des polluants est temporairement paralysée par les incertitudes scientifiques déjà mentionnées et aussi par le coût élevé de ces programmes. On estime, en effet, que pour diminuer de 10 à 12 millions de tonnes par année les émissions d'oxydes de soufre, soit une réduction de 40 à 50 pour cent, il en coûterait de quatre à sept milliards de dollars par année, en dollars de 1982. Par ailleurs, les coûts sont répartis inégalement aux États-Unis puisque, en fin de compte, ce sont les clients des centrales électriques du centre des États-Unis qui brûlent du charbon très polluant, qui devront payer la plus grande partie de la note. Le prix de l'électricité devra effectivement augmenter de 10 à 20 pour cent, ce qui ne manquera pas de compliquer la situation économique déjà très difficile de cette région. Afin de se conformer aux exigences en matière de réduction des émissions, ces centrales électriques peuvent choisir entre l'épuration du charbon, la désulfuration des fumées (au moyen d'épurateurs) ou la conversion au charbon à faible teneur en soufre. La plupart opteront sans doute pour l'épuration du charbon et la conversion à un nouveau combustible pour éviter les coûts élevés des épurateurs et les problèmes associés à leur fonctionnement, les problèmes d'élimination de la boue accumulée dans les épurateurs, sans compter la difficulté de recouvrer les coûts auprès des organismes de réglementation. En outre, ces choix entraîneront la perte de 15 000 à 25 000 emplois dans les mines de charbon de la région du nord des

Appalaches et du centre des États-Unis où l'on extrait le charbon à forte teneur en soufre. Par contre, ces pertes seront compensées par la création de nouveaux emplois dans les états de la région centrale des Appalaches et des montagnes Rocheuses, qui sont des producteurs de charbon à faible teneur en soufre.

Les propositions visant à éviter les répercussions économiques des réductions des émissions dans le Midwest, au moyen d'une formule de partage des frais à l'échelle du pays, qui permettrait l'utilisation de charbon à haute teneur en soufre pourvu qu'il y ait des épurateurs, montrent bien la difficulté de parvenir à un consensus politique. Jusqu'ici, les États-Unis ont eu comme politique en matière de lutte antipollution de faire payer le pollueur: les entreprises polluantes doivent s'attaquer au problème sans le bénéfice de subventions gouvernementales, ou si peu. Les États du nord-est, où les taux d'électricité sont les plus élevés aux États-Unis et qui souffrent le plus des précipitations acides, sont disposés (quoique avec réticence) à partager certains frais afin de réussir à faire adopter une loi sur les précipitations acides. Les États de l'Ouest s'y refusent par principe et pour des motifs d'ordre pratique. Ces États ont de faibles émissions d'oxydes de soufre parce qu'ils utilisent du charbon à faible teneur en soufre et ils ne voient aucun avantage à appuyer un programme qui vise essentiellement à régler les problèmes des états du Midwest et de l'Est. En outre, ils ne sont pas disposés à subventionner l'utilisation du charbon à haute teneur en soufre dans les états du Midwest au détriment de leurs producteurs de charbon à faible teneur. Les États du Sud hésitent à augmenter leurs taux d'électricité pour subventionner les états du Midwest et ainsi renoncer à leur avantage concurrentiel pour attirer des industries. Pour leur part, les États du Midwest estiment que le problème des précipitations acides vient du nord-est et ils insistent pour avoir des subventions au titre des immobilisations et de l'exploitation avant d'acquiescer à un programme de réduction.

Le calendrier du programme de réduction des émissions influera également sur le choix des politiques. Une faible réduction des émissions d'oxydes de soufre (deux à quatre millions de tonnes par an) peut facilement se réaliser en quatre ou cinq ans. La réduction des émissions de dix à douze millions de tonnes d'ici le début des années 1990 entraînera des problèmes de capacité au chapitre de la production du charbon à faible teneur en soufre, du transport et de la construction d'épurateurs. En outre, un tel programme pourrait nuire à la construction de centrales électriques plus efficaces et moins polluantes en prolongeant la durée de vie des centrales inefficaces nouvellement équipées d'épurateurs onéreux. Par contre, si l'on tarde trop à réduire les émissions, il pourrait en résulter des dommages irréversibles qui nécessiteraient la mise en oeuvre de programmes d'assainissement encore plus sévères et plus coûteux.

Pour être efficaces, les mesures législatives visant à réduire les dépôts acides devront concilier ces problèmes variés et souvent concurrentiels. De toute évidence, il importe d'accélérer la recherche sur les effets des dépôts acides, les rapports entre les sources de la pollution et ceux qui la subissent et les nouvelles techniques de combustion du charbon. Cependant, nous disposons actuellement de suffisamment de données sur l'ampleur et la gravité du problème suscité par le déplacement des polluants atmosphériques sur de longues distances pour commencer dès maintenant à instaurer un programme national de contrôle des émissions d'oxydes de soufre et d'oxydes d'azote.

SCIENTIFIC, ECONOMIC AND POLITICAL IMPLICATIONS OF ACID RAIN CONTROL STRATEGIES

Anthony D. Cortese
Tufts University

Over the past several years, concern about the adverse impacts of long range transport of air pollutant emissions resulting in acid precipitation has sparked heated debate in Canada and the United States over strategies to control those emissions. Concern in eastern North America has focused on reducing sulfur oxide emissions from electric utilities and large industrial facilities because sulfur oxide emissions make the largest contribution to atmospheric acid formation. Nitrogen oxides, emitted primarily from transportation sources and electric utilities, are another important source of atmospheric acid formation. The Canadian government has called for a 50 percent reduction in sulfur oxide emissions by the mid-1990's in Canada and the United States.

A major problem in establishing consensus about an acid rain control program is definition of the resource to be protected. If a control program is aimed at protecting sensitive aquatic ecosystems, reduction of sulfur oxide emissions is the logical target. However, a program to avoid possible adverse impacts on forests should focus on nitrogen oxide emissions because of their contribution to acidic deposition and photochemical reactions which produce ozone, a known plant pathogen. Moreover, it is acknowledged that reducing sulfur oxide and nitrogen oxide emissions will have the benefit of reducing adverse effects on human health, aquatic and plant ecosystems, materials, buildings and cultural artifacts, and atmospheric visibility. Over broad areas of the U.S. and Canada, there is not consensus that these effects are serious enough to warrant large reductions in general air pollution levels beyond those currently mandated.

Scientific uncertainties about the relative effects of wet and dry deposition of acid forming compounds, the rate and nature of lake acidification, and the relationship between emission sources and acid deposition make decisions on the sources to be controlled, the magnitude of the emission reductions, and the timing for such reductions difficult. Most U.S. proposals to date have focused on controlling sulfur oxide emissions from coal-burning power plants in the eastern U.S. because they contribute approximately 70 percent of total U.S. sulfur oxide emissions. Most proposals would place the major control burden on power plants in the midwestern U.S. because of their large emissions, tall stacks which inject emissions high into the atmosphere and prevailing weather patterns which carry emissions hundreds of miles over sensitive areas of Canada and the northeastern U.S. However, the apparent contribution from local sources of sulfur oxide emissions make it difficult to demonstrate that such proposals are most appropriate to protect the most sensitive areas.

This paper attempts to review these scientific, economic and political issues and provide a constructive framework for analysis of the problem of "acid rain".

Definition of the Problem

Until recently, the "acid rain" problem has been viewed in the U.S. as a problem causing a limited amount of aquatic ecosystem damage in the northeastern U.S. and eastern Canada. Moreover, except for the view of Canadians and residents of the northeastern U.S., the prevailing U.S. view has been that this limited aquatic damage is not serious enough to warrant large expenditures for control of sulfur and nitrogen oxide emissions throughout the U.S. However, viewing the problem as one of long-range transport of air pollution which includes sulfur oxides, nitrogen oxides, ozone, particulates and heavy metals across the entire

U.S. is the more appropriate way of analyzing the policy issues. The current levels of air pollution in the U.S. and Canada are having adverse impacts on human health, forest ecosystems, materials, buildings and cultural artifacts and visibility as well as aquatic ecosystems. And these effects are occurring throughout the U.S. and eastern Canada.

In 1980, approximately 23 million tons of sulfur oxides (SOx) and 20.5 millions tons of nitrogen oxides (NOx) were emitted in the U.S. Eighty-three (83) percent of SOx emissions were emitted east of the Mississippi River. Seventy (70) percent of SOx emissions are produced by electric generating facilities, mostly burning coal.

The major sources of SOx and NOx are located in the Ohio River Valley, the midwest, in the east from New England to Florida and in the southern states. As you can see from Figure 1, SOx emissions are greatest in the midwest (EPA Region I) and the South (EPA Region IV). Prevailing winds in the summer are from south-southwest to north-northeast and in the winter from the west-northwest to east-southeast.

Impacts of Long-Range Transport of Air Pollution (LRTAP)

Figure 2 is a map of mean acid precipitation levels in the U.S. measured as pH (logarithm of the hydrogen ion concentration). Water which is neutral in acidity has a pH of 7. A pH of 5.7 is considered normal due to natural atmospheric carbon dioxide concentrations. Precipitation with a pH less than 5.7 is considered acidic. Because of the log scale, a pH of 4.0 is ten times more acidic than a pH of 5.0. Although the aquatic resources most sensitive to acid deposition are located in Canada, the northeast and parts of the southeast, the greatest acid precipitation occurs in the Ohio River Valley and the mid-Atlantic/southern region of the U.S. In the eastern U.S., SOx are twice as important as NOx in contributing to wet acidic deposition. In the western U.S., NOx are the major source of wet acidic deposition.

Figure 3 is an overlay of acidic precipitation concentrations over the major forest ecosystems in the U.S. Forest damage attributed to air pollution has been reported at high altitudes in the Green Mountains of Vermont, the Adirondack Mountains of New York and the Smoky Mountains of North Carolina. These are areas with acidic precipitation throughout the year and high ozone levels in the summer. While there is not consensus about the cause of such damage, NOx are a more likely cause of damage than SOx because they contribute about one-third (1/3) of the acidic precipitation and contribute to the formation of ozone (O_3), a known plant pathogen.

Major parts of the U.S. are experiencing high ozone levels (Figure 4). The solid dark areas in Figure 4 show areas of the U.S. with daily seven-hour average ozone concentrations greater than 50 parts per billion (ppb) from June to September, 1978. Ozone is formed by complex photochemical reactions involving NOx and hydrocarbon emissions from automobiles and industrial sources. Ozone concentrations are highest during the summer because of high emissions, high humidity, high ambient temperatures, intense sunlight and stagnating weather patterns which favor ozone production.

The one-hour air quality standard in the United States for ozone is 120 parts per billion. Figure 4 indicates that average seven-hour ozone concentrations over 50 parts per billion, on a daily basis, from June to September are experienced in many areas of the country. Some 50 or 60 areas in the U.S. exceed the ozone standard at times every summer. The air quality standard of 120 ppb is designed to protect human health. Plant damage can occur at one-hour ozone concentrations as low as 50 to 70 ppb.

Air pollution causes impaired visibility over broad areas of the U.S. As you can se from Figure 5, visibility is generally greater

in the western U.S. when compared to the east. The good visibility in the west is due to low air pollution and low relative humidity. The relative humidity is an important determinant of visibility. When relative humidity is increased from 50 to 90 percent, light extinction (a measure of visibility impairment) increases by a factor of 2 to 3. The average relative humidity east of the Mississippi River is 70 percent and is often considerably higher in the summer. Fine particles in the atmosphere are the major cause of visibility impairment. The major fraction of fine particulate matter in the atmosphere are sulfate and nitrate particles. Visibility impairment is greatest in the summer with high humidity, high emissions of SOx and NOx, high temperatures, intense sunlight and weather patterns which favor long-range transport of air pollution. Photochemical conversion of SOx and NOx forms fine particulate sulfates and nitrates which absorb moisture and scatter light, thus reducing visibility.

As can be seen in Figure 5, the poorest visibility in the U.S. occurs in the Ohio River Valley where sulfate deposition is the greatest. Poor visibility is also found in the mid-Atlantic and southern regions where SOx and NOx emissions are high. Historical data* indicate that visibility declined dramatically in the U.S. from the 1950's to the 1970's. Visibility in West Virgina, Kentucky, Tennessee and North Carolina has decreased by 100 percent since the 1950's. In the Ohio River Valley and in the southern states along the mid-Atlantic coast, visibility has been reduced by 50 to 70 percent in this same time period. In the northeast, visibility has been reduced by about 20 percent.

* Trijonis, T.J. and K. Yuan. 1978. Visibility in the Northeast: Long-term visibility trends and visibility/pollutant relationships. U.S. Environmental Protection Agency. EPA-600/3-78-075. Research Triangle Park, N.C. As cited in USEPA. 1979.

Returning fo Figure 1, one can see that SOx emissions in New England, New York, and New Jersey (EPA Regions I and II) have decreased by approximately 33 percent since 1950. SOx emissions in the mid-western U.S. (EPA Region V) have increased by a factor of 3 and are 4 to 5 times greater than Regions I and II. The southeastern U.S. has increased emissions of SOx by a factor of 6 since 1950 and is the second largest SOx producing region of the U.S. The geographic pattern for NOx emissions is similar but the quantitative trend is different and alarming. NOx emissions are increasing steadily across the entire U.S. By the year 2000, NOx emissions are expected to increase by 25 percent in the eastern U.S.

This analysis demonstrates that long-range transport of air pollution is a problem all across the eastern half of the U.S. (as well as parts of the west). The highest emissions, deposition rates, and concentrations of sulfates, nitrates and ozone are occuring in the midwest, mid-Atlantic, and southeastern regions. Visibility, human health and materials damages are the greatest in those areas, not in the northeastern U.S. Indeed, a national program to control SOx and NOx emissions will provide great benefit to the entire U.S., a concept which has not been understood widely.

A major policy issue with respect to acid rain control, particularly with respect to sulfur oxide control, is the role of local sources versus distant sources. Table 1 is a compilation of eight different atmospheric deposition models, all using different assumptions, dealing with wet sulfate deposition impacting the Adirondack region. In the left hand column are the states whose SOx emissions are believed to impact Whiteface Mountain in the Adirondack Range. The numbers represent the percentage of wet sulfate concentration contributed by the source state for each model. There are two important inferences from this table. First, there is a remarkably good correla-

tion among the different models of the impact of source areas on the Adirondack region. Secondly, both local sources and distant sources are important contributors to sulfate deposition. Over 50 percent of the sulfate deposition in the Adirondack region originates in New York, Pennsylvania, Ohio and Indiana. Air parcel trajectory analysis on Whiteface Mountain in the Adirondacks in 1978 showed that some 65 percent of wet sulfate was deposited by air parcels which had been moving from the southwest to the northeast over the Ohio River Valley, and picking up New York emissions as well. Another 30 percent was from air parcels that were trajected over Quebec and Ontario. Therefore, if a sensitive receptor in the Adirondacks were targeted for protection, controlling emissions in the Ohio River Valley, New York, Pennsylvania and eastern Canada would virtually eliminate the acidic deposition.

A major point of debate between Canada and the U.S. is the relative contribution of each country's emissions to acidic deposition. As can be seen in Table 2, the U.S. contributes approximately 3 times as much sulfur to Canada as Canada does to the U.S. The Canadian contribution is significant as shown in the previous analysis and must be controlled.

The previous analyses point to the need for an international program to control SOx, NOx and ozone to prevent widespread damage to health, aquatic and forest ecosystems, materials, and visibility impairment. even if one examines specific receptor areas known to be sensitive to acidic deposition the same conclusion is reached. Figure 6 shows analysis by Fay et al. (1985). Fay picked four sensitive receptors for sulfate impact analysis: Whiteface Mountain in the Adirondack region, Mt. Mitchell in North Carolina, the Boundary Waters canoe area in Ontario, and Québec City. A close look at Figure 6 confirms the earlier analysis that Ohio, Pennsylvania, New York, Québec, Ontario, Indiana and West Virginia are the major contributors to the Adirondack

region. Ohio, Indiana, Kentucky, Tennessee, Georgia, Florida and Alabama are the largest contributors to the Mt. Mitchell area. Québec City is impacted by Québec, Ontario, New York, Pennsylvania and Ohio with smaller amounts from Indiana and West Virginia.

Emission Control Programs

The U.S. Congress has considered several pieces of legislation to control acid rain. These bills have a common thread. They generally call for and 8 to 12 million ton reduction in SOx emissions across the U.S. This translates to a 35 to 50 percent reduction in sulfur deposition. Since most of the bills target the high SOx-emitting power plants, the greatest benefit of such bills would be a reduction of wet sulfate deposition in the midwest, followed by the mid-Atlantic region, eastern Canada, the south and the northeast (see Figure 7).

Table 3 summarizes the major control options for control of SOx emissions from power plants. The most cost-effective is coal cleaning which can reduce sulfur oxide emissions about one and a half to two million tons a year in the eastern half of the United States. Major reductions require additional controls. Such an alternative for utilities is to switch fuels, i.e., from high-sulfur coal to low-sulfur coal of from high-sulfur oil to low-sulfur oil. A third solution is flue-gas desulfurization, better known as scrubbing.

Given the choice, most utilities facing a requirement for long-term reductions in emissions of sulfur oxides will choose fuel switching over flue-gas desulfurization for three basic reasons. First, scrubbers are costly and cause increased operational problems requiring new employees with different skills. Secondly, large quantities of wet sludge contaminated with a variety of potentially noxious compounds must be handled and disposed of. Finally, utilities sometimes have trouble

recovering the full cost of scrubbers from customers through utility rate setting commissions. On the other hand, the cost of low-sulfur fuel can be passed on directly to customers through the fuel adjustment clause on electric bills.

In the short term (5 years), the U.S. can obtain cost effective reductions of about 5 to 6 million tons a year of SOx using one or more of these control strategies. In the longer term (10 to 15 years), it should be possible to achieve a 10 to 12 million ton reduction in sulfur oxide emissions, particularly through methods such as chemical coal cleaning.

Two types of new combustion technology that are expected to be available in the early 1990's are lime injection milti-stage burning (LIMB) and luidized bed combustion (FBC). LIMB has two major advantages. It is about 25 to 30 percent cheaper than scrubbers, and while you get only about a 50 percent reduction in sulfur oxides (as compared to 80 to 95 percent with scrubbers), LIMB can recuce NOx emissions by 50 percent. Scrubbers do not recuce NOx emissions appreciably. Fluidized bet combustion (FBC) is being used in W. Germany in industrial facilities and some small power plants. In the U.S., FBC is being used in some small industrial facilities and being demonstrated at a large utility. This technology is hopeful for new utility boilers in the early 1990's.

The timing of control program requirements will also affect policy choices. Modest sulfur oxide emission reductions (2 to 4 million tons/year) are easily achievable in 4 or 5 years. Control programs designed too control 10 to 12 million tons by the early 1990's will encounter capacity constraints on low-sulfur coal production, transportation and scrubber construction. Moreover, such a program could impede the introduction of new, more efficient and less polluting electrical

generating units by extending the life of old, inefficient plants which have been retrofitted with expensive scrubbers. On the other hand, long delays in reducing emissions may lead to more serious irreversible damage which could make more stringent and costly control programs necessary.

What would happen if we were to pass a 10 million ton SOx reduction bill that would require the reduction to occur by the early 1990's? Given the choice, as mentioned earlier, most utilities would switch to low-sulfur coal. In fact, a 10 or 12 million ton reduction must be approached for a significant number of utilities to actually retrofit with scrubbers (See Figure 9). This is a problem because of the impact on coal production and employment.

The U.S. has 400 to 500 years of coal reserves. Eastern U.S. coal ranges from about 0.7 to 6.0 percent sulfur by weight with the majority being 2 to 5 percent by weight (medium-to high-sulfur content). Western coal ranges from 0.3 to 1.0 percent sulfur by weight (low-sulfur content). A large acid rain control program will result in a shift in coal production.

As can be seen in Figure 9, about 245,000 workers were employed in the coal industry in 1980. An important observation from this figure is that there will be a 40 percent increase (56,000 jobs) in coal production whether or not acid rain legislation is passed. However, coal production will shift from several areas of the country to other areas. Under any scenario, the Midwest and Ohio will lose coal jobs. Southern Appalachia would have the greatest increase in coal production and jobs, followed by the West.

ICF, Inc., in a study for the Acid Rain Information Clearinghouse, estimated that 25,000 to 30,000 coal job slots (only 12,000 to 15,000 miners because of retirement and attrition) would be lost in the Midwest, Ohio and northern Appalachia by 1995 if utilities were free to choose a control option under a 10 to 12 million ton SOx reduction requirement. This has an important social and economic impact on a region with high unemployment. Coal miners do not easily retrain for other employment for several reasons: well-paying jobs are not plentiful in the region; coal miners are paid about 25 percent more than construction workers; and many have been coal miners for generations.

One proposal to prevent coal production shifts and prevent job losses is the Waxman-Sikorski bill which would require the 50 largest emitting power plants to use scrubbers rather than switch to low-sulfur coal. The mandatory scrubbing requirement would be paid for by a national trust fund raising $2 billion a year for 10 years based on a one mill per killowatt-hour fee on all non-nuclear generated electricity in the U.S. The Waxman-Sikorski bill would accomplish its goal and prevent a shift in coal production and coal miner job displacement. However, the cost is high. This approach would increase the national cost of a 10 to 12 million ton SOx reduction program by at least $1 billion per year vs. a "freedom-of-choice" program with a similar reduction ($4 to 6 billion vs. $3 to 5 billion).

In analyzing the impacts of acid rain control programs it is important to consider other regional impacts. For example, in Figure 10 one can see that residential electric bills are 30 to 50 percent higher in the northern U.S. than other parts of the country. There are several reasons for this: high dependance on oil which is more expensive than coal, stringent SOx emission requirements and utility rate structure. In the midwestern and southern states where the greatest sulfur emission reductions would occur under any major reduction

program, electric bills are much lower than in the northeast. The lowest electric bills are found in the western U.S. where little sulfur is emitted due to power production from indigenous low-sulfur coal and hydroelectric facilities.

Figure 10 also contains data produced by the Massachusetts Department of Environmental Quality Engineering using information from the Office of Technology Assessment indicating the impact of electric rates of the Waxman-Sikorski approach with and without a trust fund to pay for scrubbers (cost-sharing) and a least cost (freedom of choice) control strategy. Connecticut would not have any additional control requirements under a 10 million ton sulfur reduction program because of existing low emission rates (1.1 pounds of SO_2 per million BTU heat input; midwestern rates average 3.0 to 4.5). The same is true for most western states. Connecticut and western states would face no increased costs unless there was a cost-sharing program to help pay for controls in other states. For Ohio and Indiana the least cost strategy is slightly more expensive than a Waxman-Sikorski approach with cost-sharing. Note that while the electric rate increase looks high at $2.00 to $3.00 per month, it would still leave the midwestern states with lower electric rates than in the northeast. However, the Waxman-Sikorski approach raises the cost of all states to subsidize states having to implement controls like Ohio and Indiana. But it would avoid job losses in Ohio and the Midwest.

The Waxman-Sikorski approach solves the coal production and job displacement problems of the midwest while reducing acid rain but causes economic and political problems for northeastern and eastern states because electric rates must rise in those areas to subsidize controls in the Midwest. These regional differences which have prevented consensus on a national acid rain control program merit further analysis (See Figures 11 and 12).

Northeastern States

Northeastern states are receiving heavy acid deposition (although not has heavy as in the midwest, the mid-Atlantic states and the south) and are experiencing aquatic, forest, and material damage. The northeastern states favor strong national controls to solve the problem, not only in the northeast but in other areas of the country. Despite the fact that they have high electric costs, northeastern states are willing to accept some cost-sharing because they feel that it is important to mitigate economic problems in the Midwest and because it is worth their while to spend a little bit more money to subsidize the Midwest to control some of the damage occurring in the northeast. The northeastern states tend to be oil dependent and use very little coal, although its use in increasing. Emissions in New England, New Jersey and the New York City area are very low. The greatest sources of wet sulfate deposition are states to the west and south as well as indigenous emission sources.

Midwestern States

The midwestern states have the highest emissions and deposition of SOx and NOx in the country. However, they perceive that they are receiving little damage from air pollution emmitted in the Midwest. They favor more research. If a control program is to be required they want 100 percent subsidy of controls to avoid some of the increase in electric rates and the employment problems resulting from shifts to low-sulfur coal. They have high unemployment and are not in favor of raising costs to do business even though their current electric rates are lower than in the northeast. The midwest mostly uses high- to medium-sulfur coal and, in general, believes that local sources are responsible for the damage in the northeast, not long-range transport of air pollution.

Southern States

Southern states have the second highest emissions and deposition of sulfur and nitrogen oxides. The southern states, in general, perceive little local damage occuring from air pollution although that is changing, particularly with respect to forest damage. The southern states have been increasing emissions (as mentioned earlier) and would oppose any kind of emissions growth cap because they think it would put them at a competitive disadvantage with the midwest and the northeast for jobs and economic development. (A cap on emissions growth is necessary because economic growth will increase SOx emissions by 2 million tons by 1995). The southern states favor more research before controls are imposed and would accept cost-sharing with great reluctance.

Western States

The western states have the lowest emissions of SO_2 in the country. They use very-low-sulfur coal. In the west NOx emissions are important; therefore any program that is going to get favorable acceptance by the western part of the country has to include NOx controls. They tend to perceive acid rain as an eastern problem although that perception is changing. They tend to believe in the "polluter pays" principle, i.e., that there should be no subsidy for controlling emissions. This is important to them philosophically and economically. Western coal production was slowed down by the 1977 Clean Air Act Amendments which required all new power plants burning coal to use flue-gas desulfurization equipment regardless of the sulfur content. This requirement has encouraged use of locally available (high-sulfur) coal in the midwest instead of use of western low-sulfur coal and has raised electric rates in the west due to use of flue gas desulfurization on low sulfur coal power plants. They do not want a national acid rain control

program which encourages protection of coal markets in the East. Western States oppose a cap on emissions.

These regional concerns make it difficult to craft a national acid rain control program. The two-phased approach favored by the Northeast Governors with an innovative cost-sharing program deserves consideration as a vehicle for achieving national consensus and should be explored carefully.

Scientific Uncertainty and Public Policy

What level of scientific certainty is required before action should be taken on problems like the long-range transport of air pollution (LRTAP)? In fundamental science we look for incontrovertible evidence or else we would be building on shifting sands. If society were to wait for incontrovertible evidence on LRTAP such as the mechanisms of damage to ecosystems, how much damage is occuring and what the causes are, it might take decades before we gather the information and take action. On applied science and public policy which is what we are talking about with respect to long-range transport of air pollution, we often begin application of solutions before the requirements for complete certainty are satisfied. When this works it is called visionary and imaginative. When it does not it is called dumb, and some who are in elected office are removed.

An example of the former, the visionary and imaginative kind of solution, is the problem of sewage contaminated water. In 1854 there was a public health incident in London called the Broad Street pump epidemic. At that time, Dr. Snow performed studies which determined that the cholera epidemic occurring in that area was due to people drinking sewage-contaminated water from the Thames River. It took nearly 30 years to discover that a bacterium found in human feces was

the precise cause of the cholera. Yet the circumstantial evidence was sufficient to take action to prevent people from drinking sewage-contaminated water soon after the epidemic was discovered.

It could be argued that society is in the same place with respect to long-range transport of air pollution. I think that there is enough evidence today that sulfur oxides, nitrogen oxides and ozone are creating serious enough effects that society should take action now to reduce air pollution concentrations in the environment considerably. Many of these effects, as we have heard at this conference, are irreversible. The aquatic and the health effects may be and probably are irreversible. Impacts on materials and cultural artifacts (buildings and monuments) are definitely irreversible. The impacts on forest ecosystems may be irreversible. If we do not act now, even greater and more costly reductions will be needed. It is a classic case of "you can pay me now or you can pay me later." Do we act now to try to reduce a reasonable amount of pollution in the shortest period of time or do we wait and pay a much greater bill in the long run?

I believe that the time is ripe for a new look at air pollution control in this country. The fundamental approach to air quality management, that bases control action on the air quality levels set to protect against any kinds of effects and which assumes that local sources are the cause of poor air quality, has not worked as well as we had hoped. While the air quality approach has resulted in major emission reductions in this country, we discovered in the early 1970's that long-range transport of ozone and precursor emissions of nitrogen oxides and hydrocarbons have caused air quality problems hundreds of miles away including sparsely populated areas with little locally generated air pollution. In the late 1970's long-range transport of emissions causing acidic precipitation and aquatic ecosystem damage became widely known. In the 1980's we are concerned with forest damage that may be caused by

a mix of locally generated and distant emissions that produce nitrogen oxides, ozone, acidic deposition and heavy metals.

The United States should move quickly to enact a program to control NOx and SOx emissions and ozone. The U.S. should also accelerate its program of research on technology to burn coal more cleanly. As a society, we must do this to improve environmental quality and maintain energy independence. We need legislation and economic incentives to use technology such as lime injection multi-stage burning (LIMB), which has the potential to reduce NOx and SOx substantially at a lower economic and environmental cost than scrubbers. It is imperative that any legislation to control this problem must include measures to mitigate the regional environmental, social and economic impacts of the program.

BIOGRAPHY

Anthony D. Cortese received a Doctorate in Science (environmental health) in 1976 from the Harvard School of Public Health. From 1976 to 1978, Doctor Cortese was director of the Division of Air and Hazardous Materials of the Massachusetts Department of Environmental Quality Engineering (DEQE). As director, he was in charge of the control of air and noise pollution as well as hazardous and solid materials disposal. From 1979 to 1984, he was commissioner of the Massachusetts Department of Environmental Quality Engineering whose mandate is to control air and water pollution, manage hazardous and solid waste, and protect drinking water and wetlands. Moreover, he was adjunct associate professor in civil engineering and environmental policies at Tufts University (1981-1984). In 1984, Anthony D. Cortese was named director of the Center for Environmental Management. He directs a multidisciplinary effort to find long-term solutions to environmental problems such as hazardous waste, solid waste, toxic discharges into the environment and transboundary pollution. He is also the author of many articles.

TABLE 1

Comparison of Model Predictions for percentage of Ambient Sulphate at Adirondack Receptor+

Source Strate / Model	THIS	TPAPER#	MOE*	ASTRAP*	ENAMAP	UMACID*	MEP*	AES*	CAPITA*	MEAN	S.D.
PA	17.4	13.2	18.1	19.7	15.9	23.6	19.5	18.6	18.3 ± 3.0		
OH	14.8	16.2	15.9	26.7	20.9	17.4	18.8	17.7	18.6 ± 3.8		
NY	10.5	9.4	24.2	9.3	12.4	23.4	13.3	10.1	14.1 ± 6.2		
IN	7.6	9.5	7.8	9.7	8.1	5.1	7.2	8.9	8.0 ± 1.5		
WV	6.6	5.2	4.9	7.9	5.7	5.6	6.7	8.9	6.4 ± 1.4		
MD/DE/NJ/DC	6.4	3.4	4.2	2.9	3.5	5.5	4.0	3.1	4.1 ± 1.2		
MA/CT/RI	5.8	2.9	1.3	2.7	4.7	3.6	2.6	1.7	3.2 ± 1.5		
MI	5.2	7.8	3.9	7.3	7.2	6.1	9.0	5.9	6.6 ± 1.6		
IL	3.9	6.5	4.0	2.7	5.1	2.3	6.0	5.4	4.5 ± 1.5		
KY	3.4	3.5	3.7	4.4	3.0	1.7	2.1	3.8	3.2 ± 0.9		
Other	18.4	32.4	12.0	6.7	13.5	5.5	10.8	15.9	14.4 ± 8.5		

Fay, 1983

+ Sources in 31 state region only (4)

* Data from (5)

Ref.: Fay, J.A., D. Golomb, J. Gruhl, 1983, Controlling Acid Rain, Energy Laboratory. Report No. MIT-EL83-004 (41 pages)

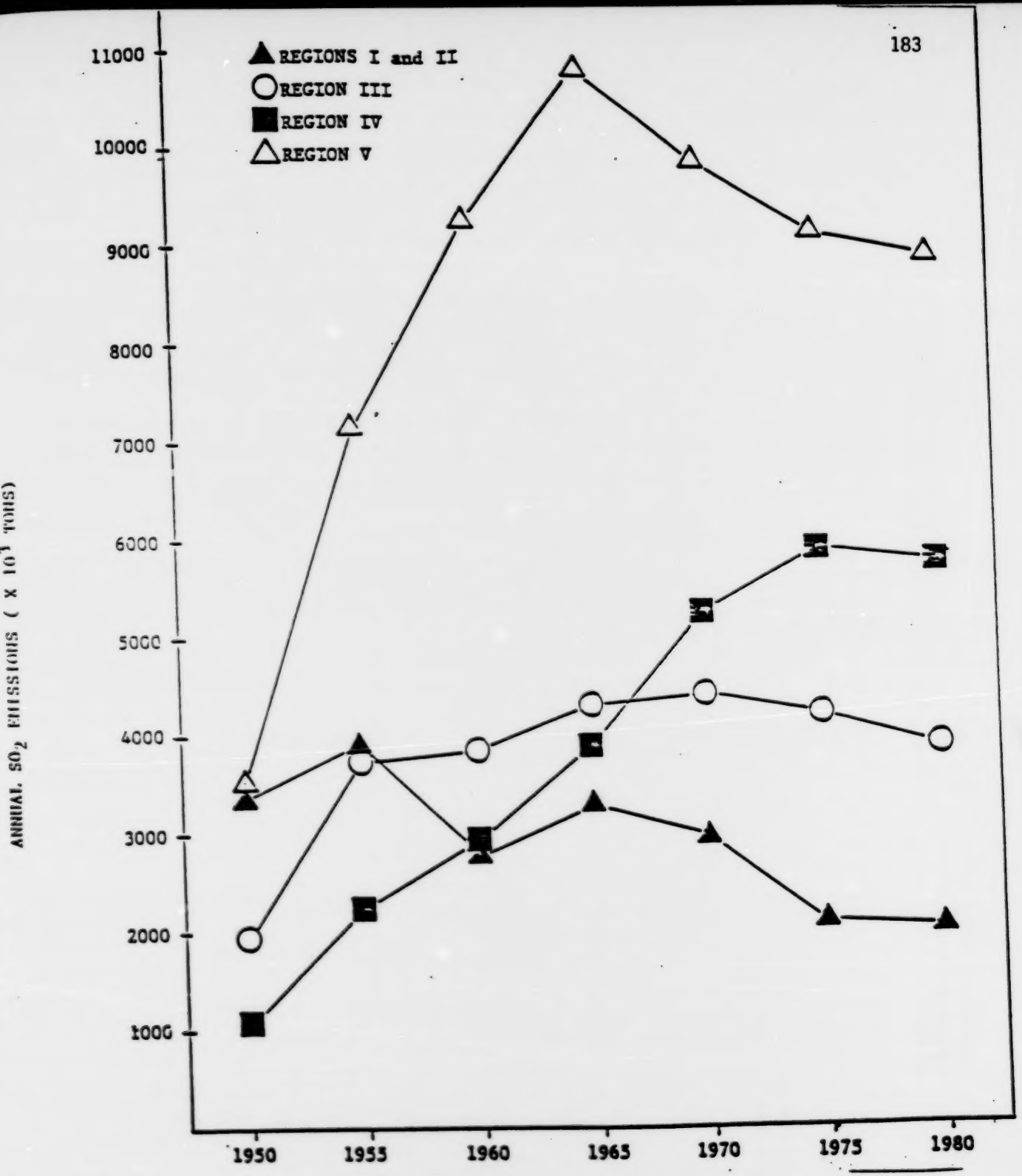


Figure 1. Historical trends in SO_2 emissions for EPA Regions I and V, Ohio, Indiana, and Massachusetts. Data from the U.S./Canada Work Group 3B, Memorandum of Intent on Transboundary Air Pollution, (1982).

TABLE 2

1980 Eastern North American transboundary fluxes

	Fay et al. (1985)+	Galloway and Whelpdale (1980)	Olson et al. (1982)
Flux to Canada from U.S. sources* (Tg S y^{-1})	1.7	2.0	1.2
Flux to U.S. from Canadian sources* (Tg S y^{-1})	0.4	0.7	0.35

* Eastern U.S. sources = 10.2 Tg S y^{-1}; Eastern Canadian sources = 2.15 Tg S y^{-1}

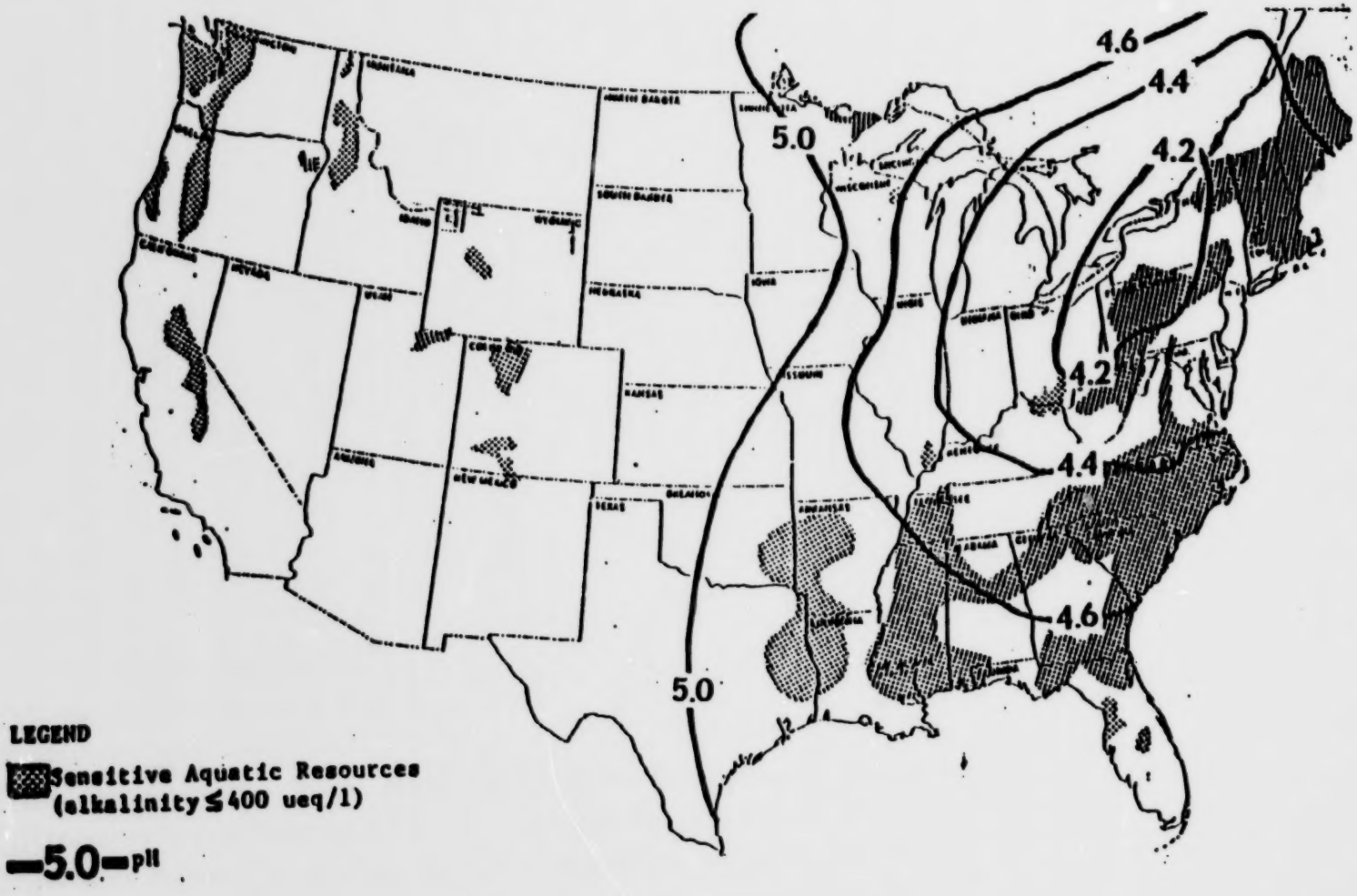


Figure 2. Regions of potential damage to sensitive aquatic resources (alkalinity < 400 ueq/l) due to low pH levels of wet deposition (1982). (Adapted from Omernick, 1983; NAPAP, 1984).

Table 3. SOx control options

Short term	Long term
. Coal cleaning	. Advanced coal cleaning
. Fuel switching	. New Combustion + treatment technology - Lime injection/multistage burning - Fluidized bed combustion
. Least emissions dispatch	
. Flue gas desulfurization	. Energy conservation

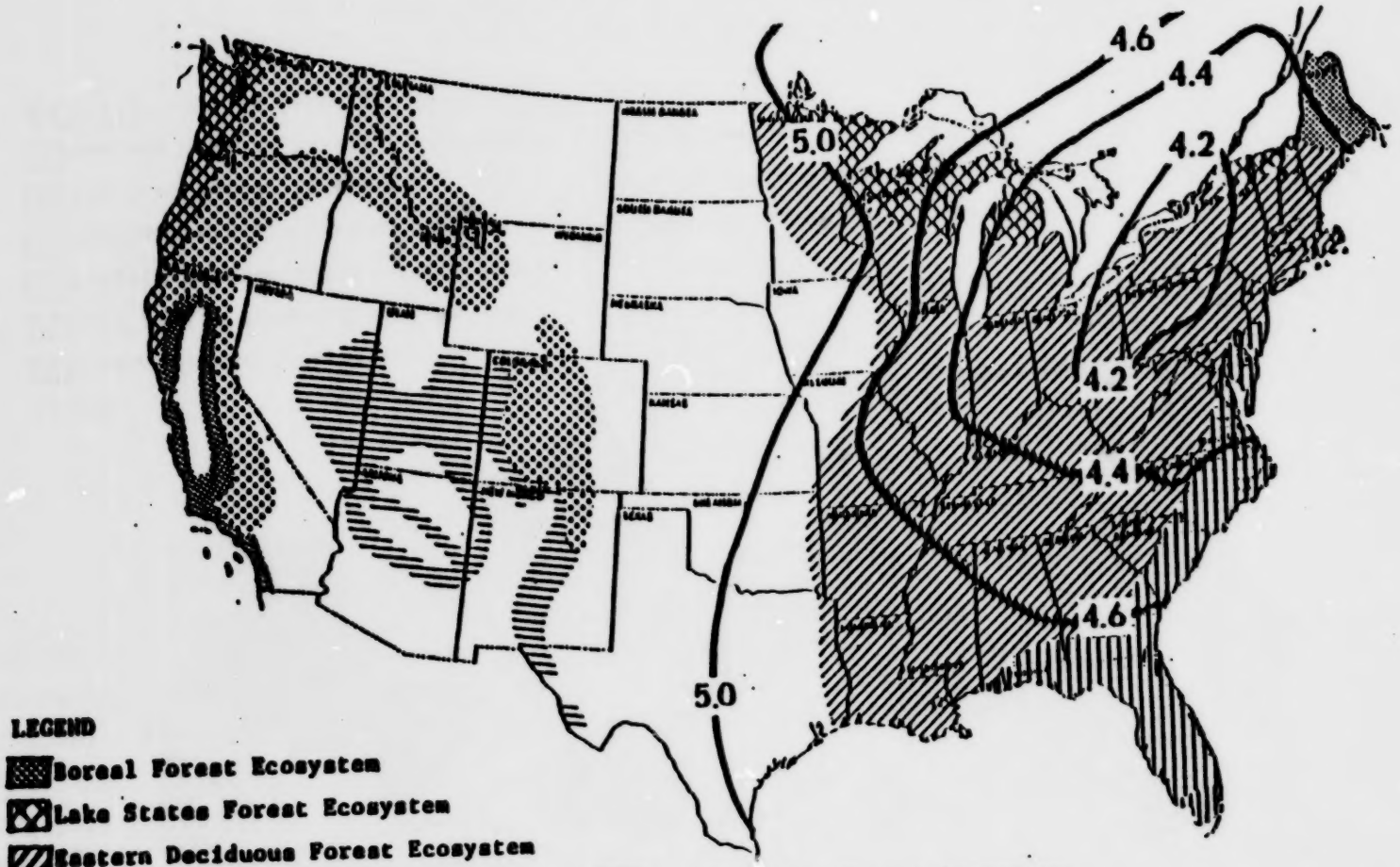


Figure 3. Regions of potential damage to forests due to low pH levels of wet deposition (1982). (Adapted from McLaughlin et al., 1982; NAPAP, 1984).

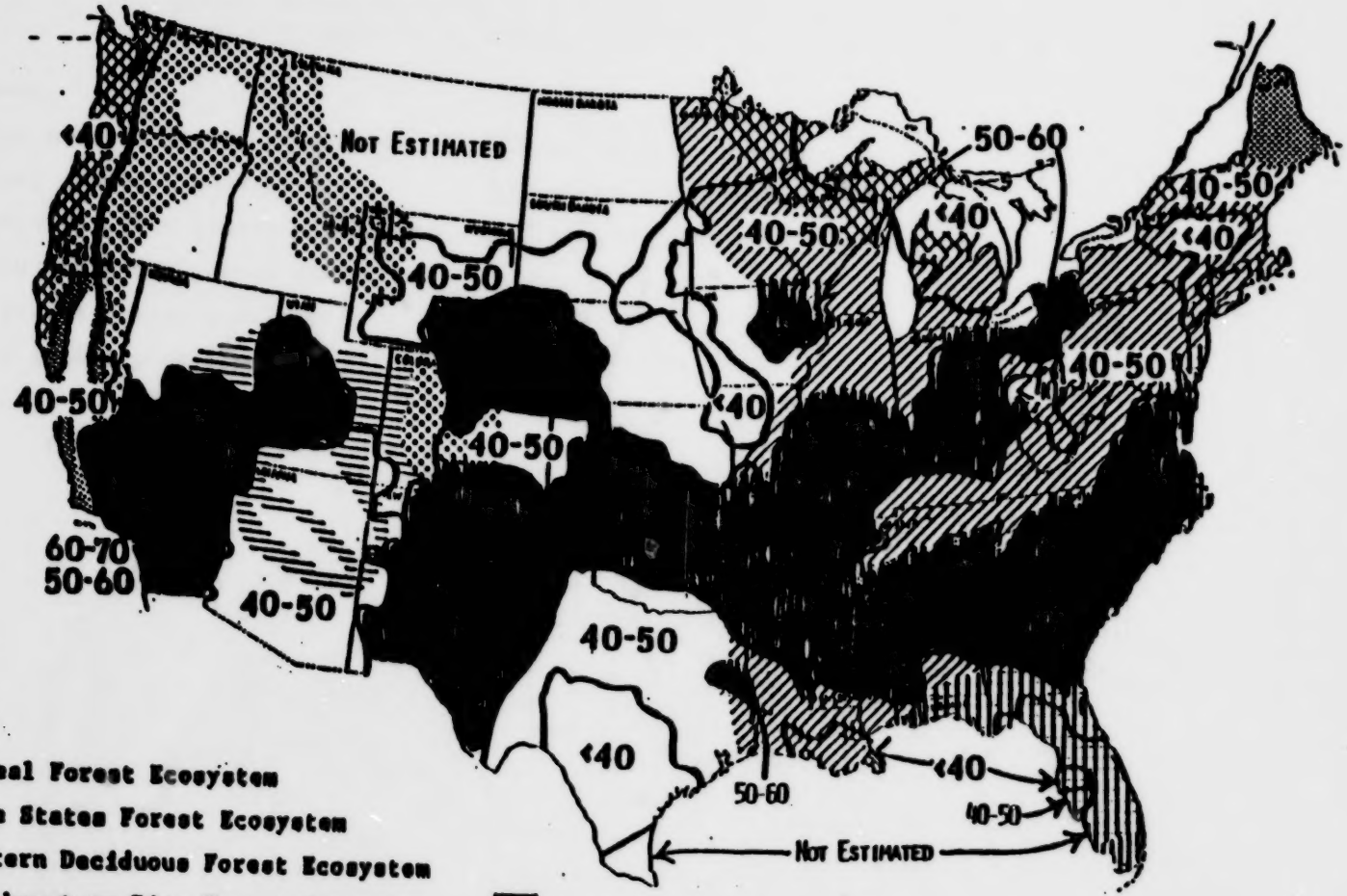


Figure 4. Regions of potential damage to forests due to high ozone levels (ppb; daily seven-hour average) (June-September average, 1978). (Adapted from McLaughlin, et al., 1982; Office of Technology Assessment, 1984).

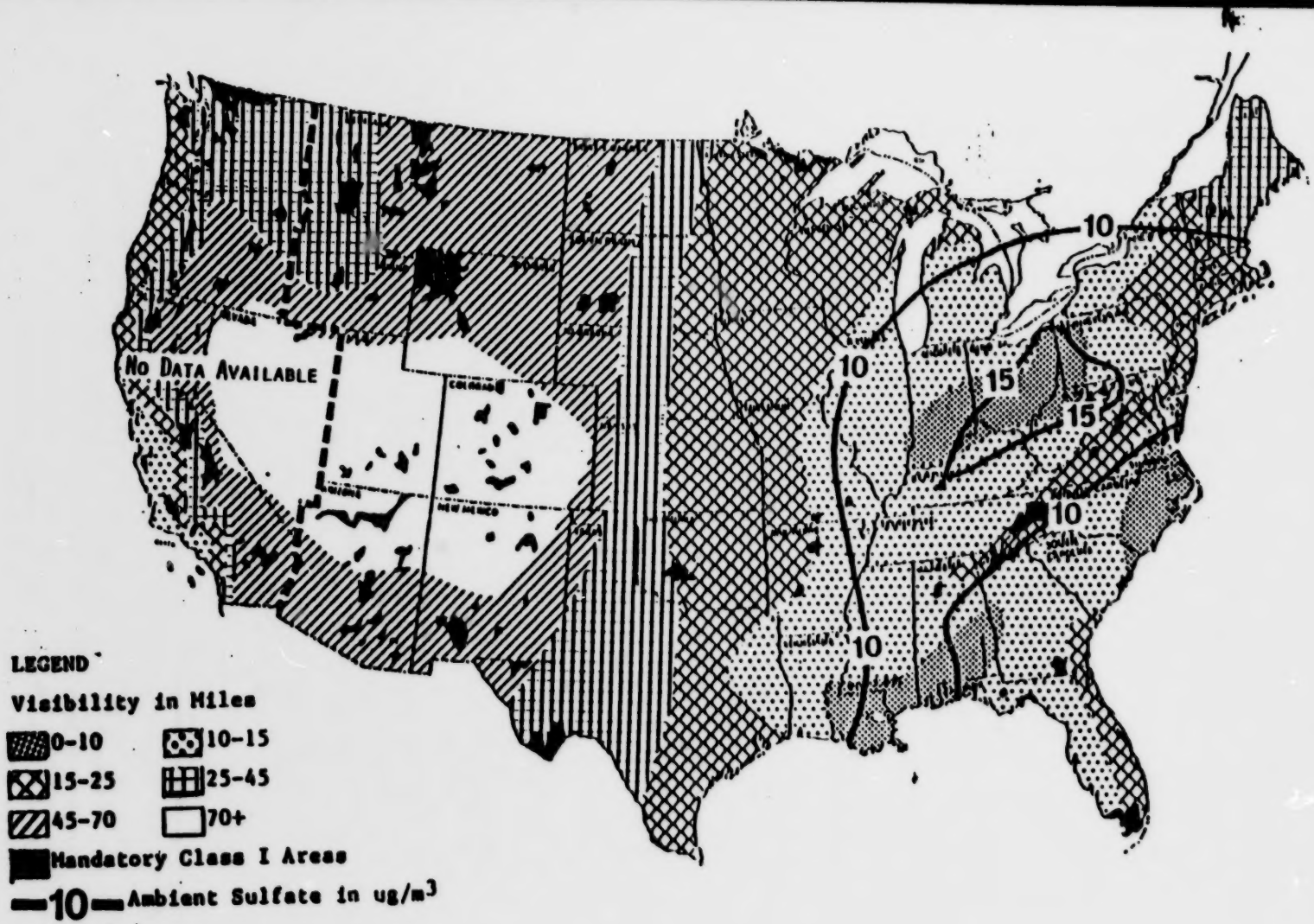
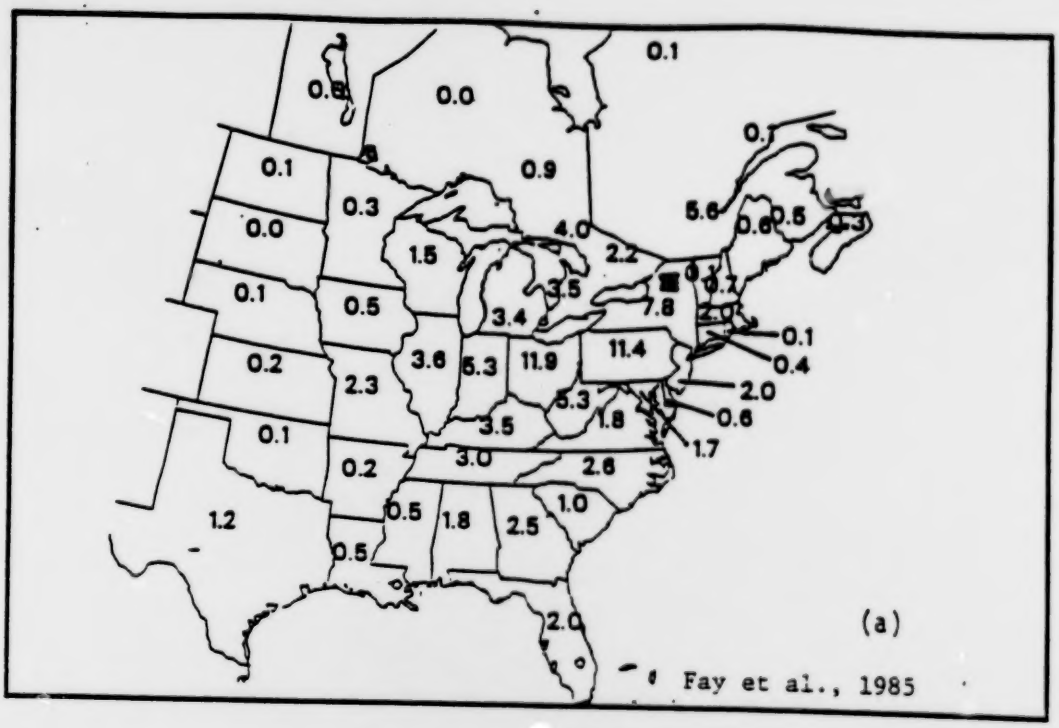


Figure 5. Regions of potential visual impairment due to high ambient sulfate levels (ug/m^3 yearly average) during the mid 1970's. (Adapted from U.S. EPA, 1979; Wilson et al., 1980).



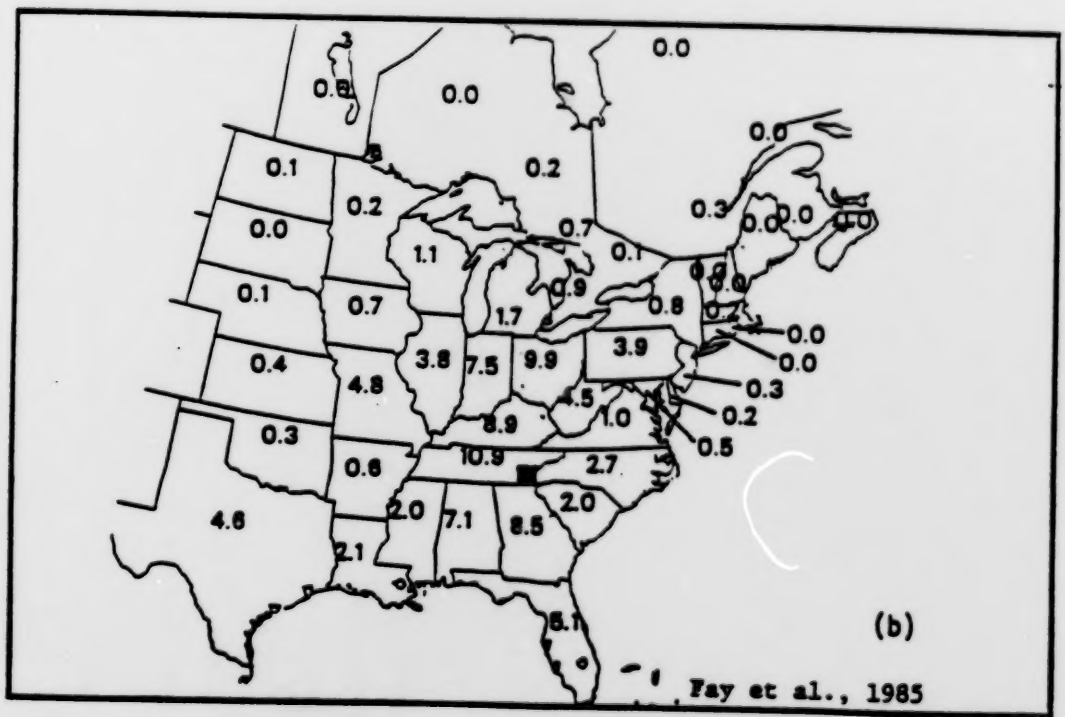
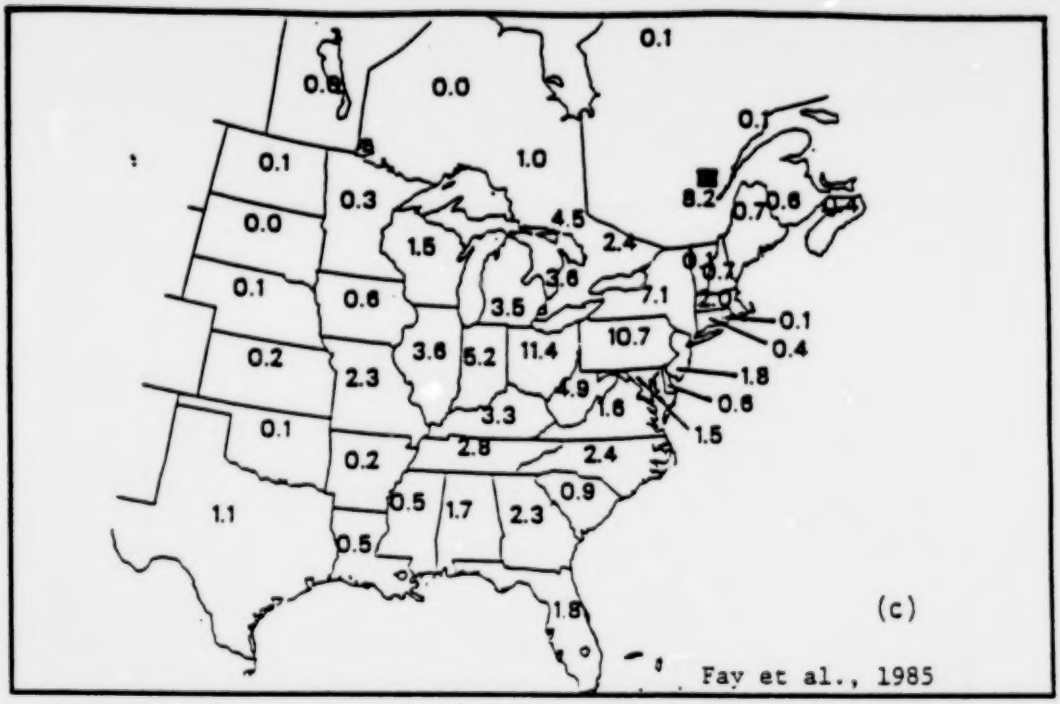


Figure 6. Source apportionment of wet sulfate deposition (percent per state or sub-province) at (a) Whiteface Mountain, New York, (b) Mt. Mitchell, North Carolina, (c) Québec City, Québec, and (d) Boundary Waters, Ontario.

Fay, J.A., D. Golomb and S. Kumar.
Source Apportionment of Wet Sulfate
Deposition in Eastern N. America Energy Laboratory
Report No. MIT-EL85-001, 1985



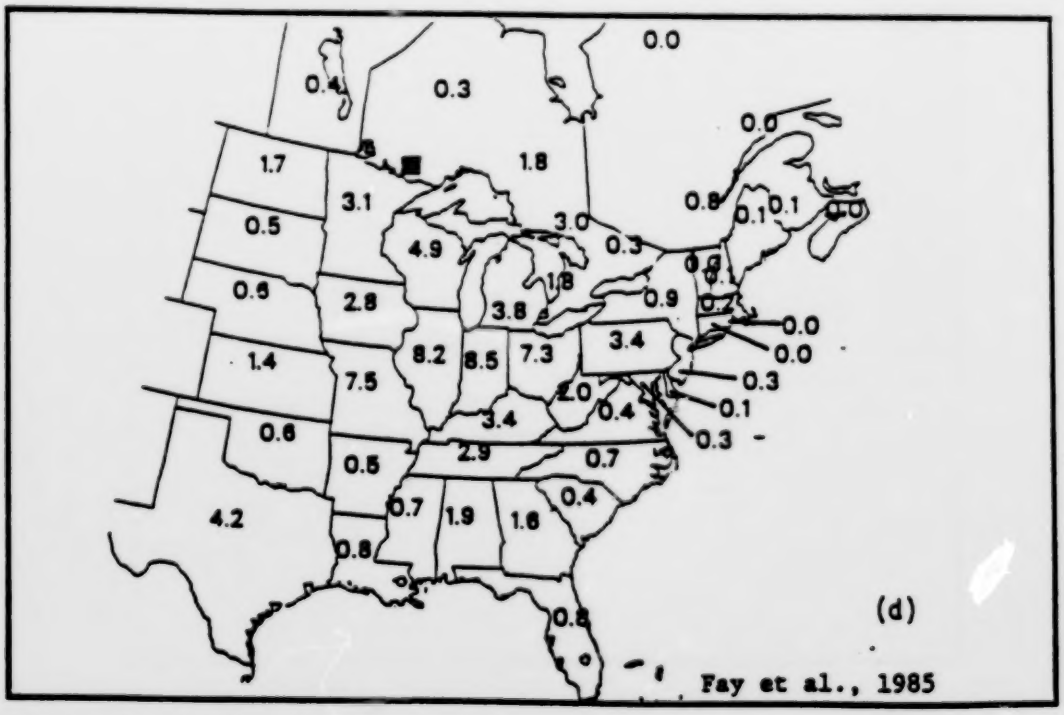


Figure 6. Continued
Fay, J.A., D. Golomb and S. Kumar.
Source Apportionment of Wet Sulfate
Deposition in Eastern N. America Energy Laboratory
Report No. MIT-EL85-001, 1985

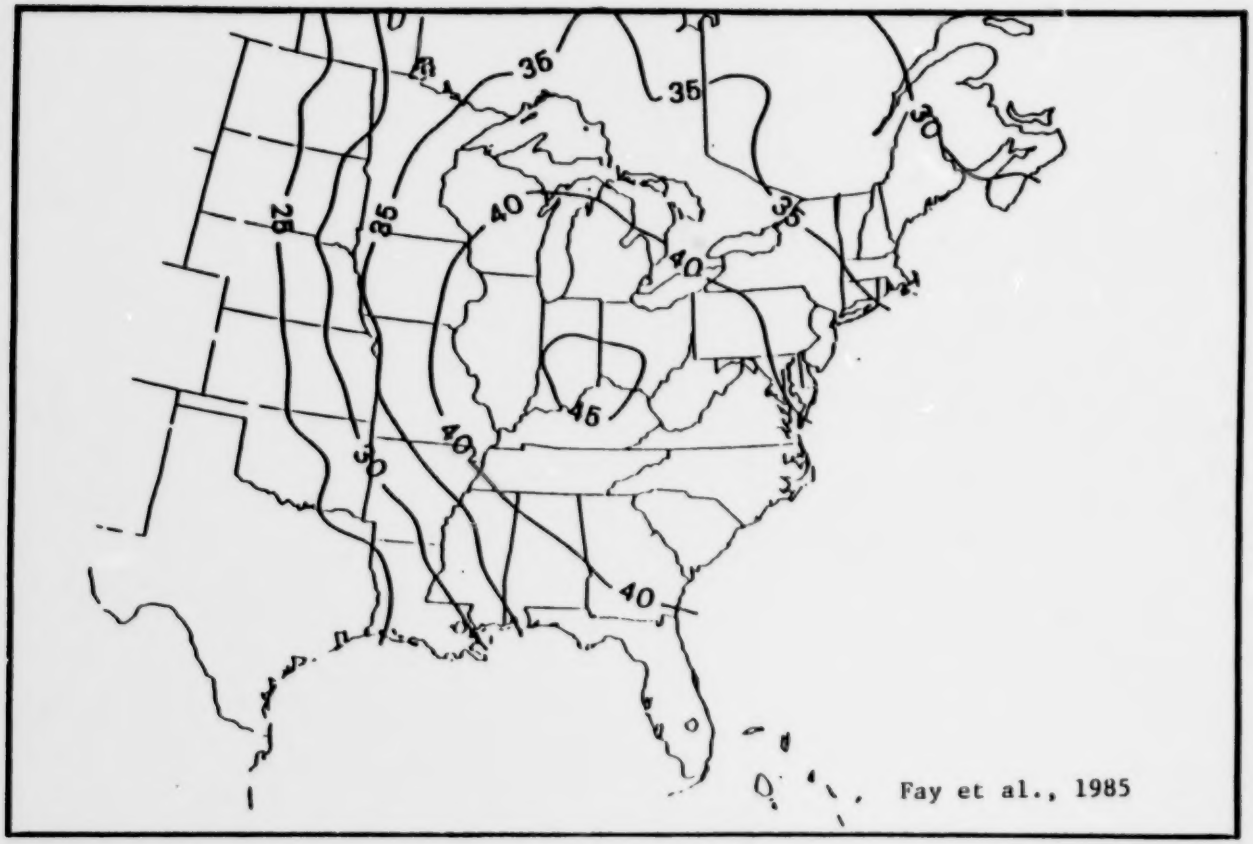


Figure 7. Calculated wet sulfate deposition reduction for Mitchell bill (percent below 1980-82 values).

Fay, J.A., D. Golomb and S. Kumar
Source Apportionment of Wet Sulfate
Deposition in Eastern N. America Energy Laboratory
Report No. MIT-EL85-001, 1985

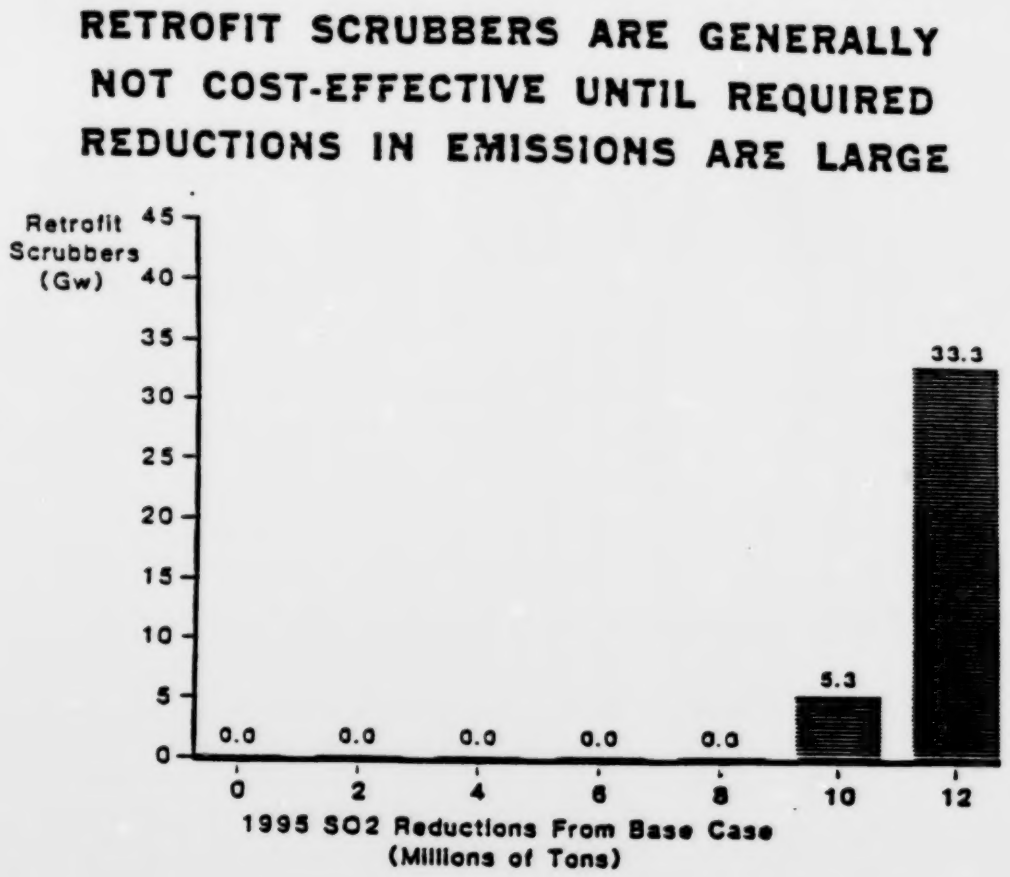
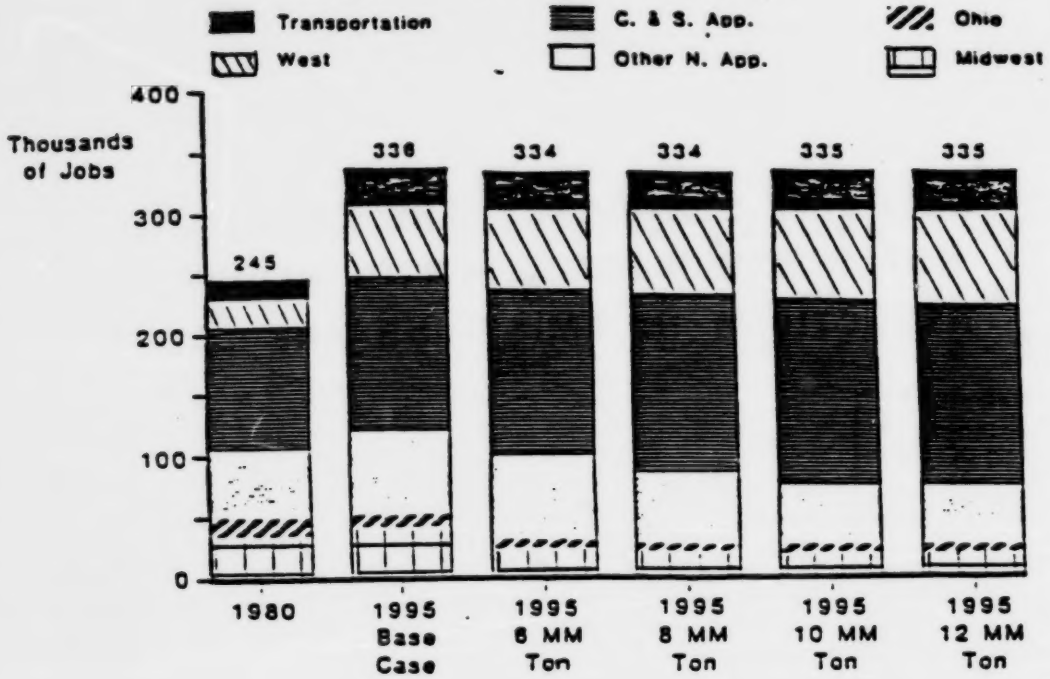


Figure 8. C.H. Stauffer, Jr., "Cost and Coal Market Effects of Alternative Approaches for Reducing Electric Utility SO_2 Emmissions" for Acid Rain Information Clearinghouse, 1984.

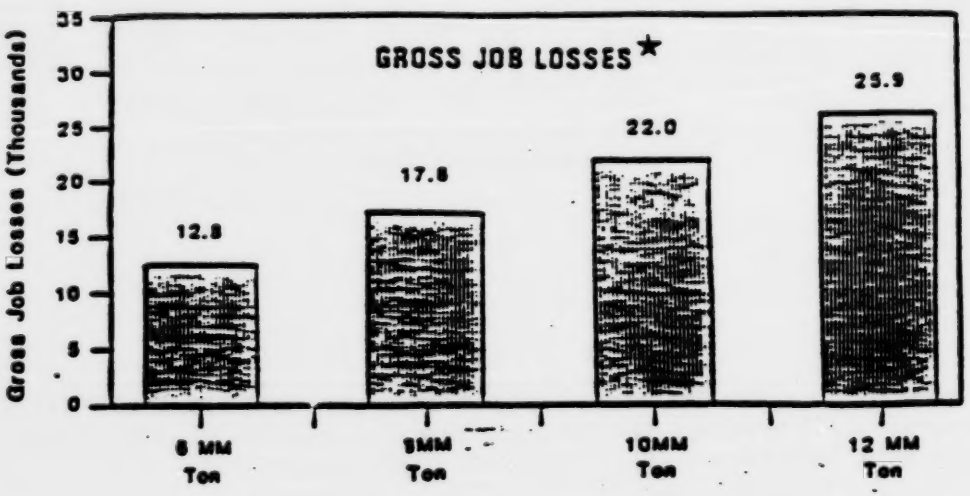
FIGURE 9

194 C.H. STAUFFER, JR. "COST AND COAL MARKET EFFECTS OF ALTERNATIVE APPROACHES FOR REDUCING ELECTRIC UTILITY SO_2 EMISSIONS" FOR ACID RAIN INFORMATION CLEARINGHOUSE, 1984.

FUEL SWITCHING WOULD SHIFT JOBS BUT DOES NOT ELIMINATE THEM



FUEL SWITCHING WOULD RESULT IN JOB LOSSES IN CERTAIN AREAS



★Sums direct job losses in each region when employment declines.
Does not offset job losses with job gains in other regions.
Job losses defined as lower of change from 1980 or from base case

ICF INCORPORATED

Figure 10. Utility rate cost comparison**

$Increase in res. utility bills

STATE	AVE MONTHLY UTILITY RESIDENTIAL BILL*	WAXMAN-SIKORSKI EMISSION REDUCTION (10^3 T/YR)	WAXMAN-SIKORSKI (NO COST-SHARING)	LEAST COST CONTROLS	WAWMAN - SIKORSKI (COST-SHARING)
CONNECTICUT	48.86	-	-	-	0.20
MASSACHUSETTS	43.73	104.3	0.29	0.29	0.64
GEORGIA	27.72	453.7	1.88	1.75	1.69
W. VIRGINIA	29.88	571.4	1.61	1.57	1.14
OHIO	34.31	1589.7	3.07	2.18	2.15
INDIANA	31.29	1172.0	3.48	2.37	2.23
WYOMING	19.03	7.3	-	-	0.40
UTAH	36.95	-	-	-	0.39

* DOE: 500 KWH/MONTH, JANUARY 1, 1982

**

Figure 11. Regional concerns on acid rain control.

NORTHEAST	MIDWEST
. Receiving heavy deposition & damage	. Highest emissions and deposition
. Favor strong controls	. Perceive little damage
. Accept some cost sharing	. Favor more research
. Low emissions	. Want 100% subsidy of controls
. Oil-dependent	. High unemployment
. Greatest source of deposition from states west and south	. Use high-sulfur coal
	. Believe local sources responsible for northeast damage

Figure 12. Regional concerns on acid rain control.

SOUTH	WEST
. High emission and deposition	. Lowest emissions of SO_2
. Perceive little damage	. NO_x emissions important
. Oppose cap on emissions	. Perceive acid rain as eastern problem
. Accept some cost sharing	. "Polluter pays"
. High growth area -- increasing emissions	. Oppose cap on emissions
. Favor more research	. Oppose mandatory technology
	. Use low-sulfur coal

TROISIÈME SÉANCE/SESSION III

INITIATIVES RÉGIONALES EN MATIÈRE DE PRÉCIPITATIONS ACIDES/ REGIONAL INITIATIVES ON ACID RAIN

Président/Chairman:
Gérard L'Écuyer
Ministre de l'Environnement et de la Sécurité
et Santé du milieu de travail du Manitoba

NEW ENGLAND STATES

Wallace E. Stickney
Special Assistant for Environmental Affairs
Office of the Governor of New Hampshire

RÉSUMÉ

Wallace E. Stickney décrit les mesures que les États de la Nouvelle-Angleterre ont l'intention de mettre en oeuvre pour réduire les émissions responsables des dépôts acides. Bien que les sources d'émissions de la Nouvelle-Angleterre ne soient responsables que de 2,3 pour cent des émissions d'anhydride sulfureux et de 2,6 pour cent des émissions d'oxydes d'azote, la région a arrêté des orientations fermes en matière de lutte contre les précipitations acides et a élaboré un programme de réduction des émissions d'anhydride sulfureux. Ainsi les gouverneurs ont adopté au plan régional une résolution prévoyant l'établissement d'un plafond pour les émissions de SO_2. Le Maine, le Massachusetts et le New Hampshire qui doivent procéder à la réduction de leurs émissions ont déposé des lois en vue de la mise en oeuvre de leurs mesures. Au chapitre des oxydes d'azote, le Connecticut, le Massachusetts et le New Hampshire ont élaboré leur propre programme visant à faire respecter les mesures relatives aux normes d'émissions des véhicules-automobiles.

Des études ont également été amorcées qui permettront d'établir des données de base pour raffiner davantage les programmes et les stratégies de réduction des émissions. La Northeast States for Coordinated Air Use Management (NESCAUM) effectue une analyse de l'efficacité, de l'applicabilité, des répercussions environnementales et des implications économiques régionales des hypothèses de réduction des émissions polluantes. Les États du Connecticut, du New Hampshire, du Massachusetts et du Vermont effectuent également des études qui présentent une application ou une importance régionale. (E)

WALLACE E. STICKNEY
Assistant for Environmental Policy
Governor John H. Sununu's Office

Good morning Ladies and Gentlemen. It is my pleasant task to attempt to describe, at least in general terms, the activities which are now under way in the New England region to reduce the emissions which cause acid deposition.

I should emphasize one caution at the outset. We are just now embarking on rigorous studies which will develop the baseline data and reduction options to the precise degree of detail required to fine tune our reduction plans and strategies. These studies (which I will review in more detail later) are supported by our individual States and the U.S. Environmental Protection Agency's State Acid Rain Projects (STAR) program. They are coordinated through our regional cooperative air pollution control arrangement, called Northeast States for Coordinated Air Use Management (NESCAUM).

My goal here is not to confuse you all with bureaucracy and acronyms, but rather to point out that as these definitive studies are completed, there may be some adjustments in the numbers which I will use in today's presentation. However, as you shall see, the New England region has developed firm policy directions regarding air pollution control and has begun to implement these policies.

First, a few words to set the context. This is important because as environmentalists we know that there is no such thing as a free lunch, even for us. We know we must carefully weigh our decisions to ensure that they move us along in the path of overall environmental benefit, rather than along some narrow course which may address the

concern of the moment but make something else worse. Therefore, I shall summarize a few key statistics.

There are just over 12 million people in New England or about 5.4 percent of the population of the United States. We consume only 3.7 percent of all the electricity used in the United States, but we pay about 5 percent of the United State's electric bill. New England chimmneys are responsible for 2.3 percent of the sulfur dioxide and 2.6 percent of the nitrogen oxide emitted in the United States. Generally speaking, therefore, we use less electrical energy, pay more for it and emit less pollutants on a unit basis than other sections of our country (and Canada, too).

There are three main reasons for this. First, we are still essentially a petroleum based economy, even though we are using increasing amounts of coal. The second reason is that 34 percent of our power is generated by nuclear power plants, which do not emit sulfur or nitrogen oxides into the air. Third, we have over the years gotten along with less energy because it is harder to get and it costs more.

New Englanders are known for our thrift. Having no indigenous energy source has always made us unusually frugal in the use of energy, and the 250 percent price increase in oil for our power plants due to the energy crisis of the 70's made us more conservation minded than ever. Therefore, even though we still have a great commitment to conservation, we have already gotten a lot from conservation. Our increasing population and our successful economy throughout the region have resulted in annual increases in electrical usage of over 4 percent per year over the last few years. As a matter of fact, the peak winter load for 1984/85 was 6.4 percent over that of the 1983/84 winter season. Furthermore, the 1984/85 peak exceeded the winter peak that had not been projected to occur until 1987. Therefore, we, too, must learn to make our existing

power plants produce less air pollution because as it stands now, even when the plants now under construction are completed, we will still need additional sources of electricity.

In New England, therefore, we face a quadruple challenge: we have a sensitive ecology which we treasure for its intrinsic values and because of its great economic importance to us. Our energy costs are now, and probably always will be, higher than the national average, so additional costs of further sulfur removal are important to us. Our energy demands lead many of us to believe that we simply cannot shut down old, dirty plants (we must not only make them run, we must make them run cleanly!). Finally, we must recognize that, although our emissions are small compared to those of the central portions of our country (and even east-central Canada), we must do our part to remove those emissions which contribute to our problem even if they are a relatively insignificant contribution and even if removing these emissions will not solve the problem.

The region has recognized these realities and is moving forward. On the interregional and national scene, our governors have engaged in frank and forthright dialogue with their counterparts around the country and in Canada.

On the regional scene, our New England governors adopted a resolution calling for a cap on sulfur emissions last year. Furthermore, the three states which for one reason or another will need to make reductions to meet acid rain reduction goals have all filed state legislation to implement their policy thrusts. Several State studies and the NESCAUM studies are underway.

The details of these are as follows:

First the State Legislation: As you will note, I will take these in alphabetical order in order to ensure that I am not showing favoritism.

1) Maine: Maine officials have proposed a bill which will turn the policy of imposing a cap on sulfur emissions into State Law, and set a schedule for adopting new sulfur in fuel regulations to ensure that the cap will not be exceeded.

2) Massachusetts: Legislation is being considered within the Massachusetts Legislature which will set a requirement for attaining a statewide emission rate of 1.2 pounds of sulfur per million BTU by 1995 unless National Legislation, which requires at least a 10 million ton reduction nationwide, is adopted by the United States Congress.

3) New Hampshire: Our New Hampshire House Committee on Environment and Agriculture has favorably reported out a bill which calls for a 25 percent reduction in sulfur emission in the State by 1990. It also calls for the completion of a report to the Legislature and the Governor as to how the State should best comply with a 50 percent reduction or with the most stringent national program to have been proposed by that time. New Hampshire's Air Resources Agency will be carrying out extensive studies as to the economic and environmental impacts of various decision scenarios. This work will receive partial funding from the EPA'S STAR Program and will be carefully coordinated with, and to a certain extent, based on the work of the NESCAUM group which is also funded by the STAR Program.

Secondly, the State studies: The States of Connecticut, New Hampshire, Massachusetts and Vermont have been granted U.S. EPA STAR funding for various acid rain related activities. One common factor here is that these projects must have regional application or significance.

Third, the regional studies: NESCAUM has been awarded STAR funding to provide the regional baselines and perform a rigorous review of the effectiveness, implementability, environmental impacts and economic implications of available reduction scenarios.

Fourth, mobile source emmissions: As you all know, vehicles manufactured in the United States must meet rigorous pollution control requirements at the time of manufacture. On a national basis, their performance is monitored by a statistical sampling of the cars in the fleet. However, three New England States have their own programs designed which ensures that automobile emission contracts are maintained in good working order, and that nitrogen oxides in other precursors to acid rain which are emitted from automobiles will be reduced as much as possible.

Connecticut has had an inspection and maintenance program in place for a number of years and Massachusetts has successfully implemented an inspection and maintenance plan over the last few years. New Hampshire, is implementing an antitampering program, which will require that the pollution control systems must be in place in order to pass the annual or semiannual safety inspection, and is now considering legislation for a limited inspection and maintenance program for automobiles in our burgeoning southern tier. Therefore, in addition to our good record in sulfur emissions, and the sulfur reduction programs which we are now developing, the region has shown leadership in the reduction of automotive pollutants as well.

In summation, I would suggest that the New England region is doing its part in reducing its own stationary and mobile source emissions, emissions which add only insignificantly to the region's acid deposition problem. We have been actively seeking the support of other regions of our nation and their counsel in developing sulfur reduction programs which can maintain the vitality of the various segments of our coal industry while, at the same time, significantly reducing the emissions of sulfur and nitrogen oxides to our atmosphere. It is clear that the region will continue to implement its own reduction programs while it continues on all fronts to stimulate creative and imaginitive thinking, in other regions of the country, in order to achieve our common goals of a healthy economy and a healthy environment.

BIOGRAPHY

Wallace E. Stickney was graduated from Harvard University (1981) with a master's degree in Public Administration. Currently on assignment from the Environmental Protection Agency (EPA), he has been acting as special assistant to the Governor of New Hampshire for environmental affairs since 1983. During his career, Wallace Stickney taught at Northeastern University in Boston and worked for the EPA in the Boston region. He was also director of the Environmental and Economic Impact office of the Boston-EPA from 1973 to 1980 and 1980 to 1982, as well as chief of the Technical Support Branch (Air Management Division) EPA, Boston (1982-1983).

A REGIONAL PERSPECTIVE ON ACID RAIN: NEW YORK, PENNSYLVANIA AND NEW JERSEY

Henry G. Williams

Commissioner of the Department of Environmental Conservation
New York

RÉSUMÉ

Henry G. Williams présente les initiatives prises par les États de l'Atlantique-Centre pour s'attaquer au problème des précipitations acides. L'État de New York, qui contribue à 17 pour cent du problème auquel il est confronté, adopta en août 1984 une loi sur le contrôle des dépôts acides ainsi qu'un programme et une stratégie de réduction des émissions polluantes. L'État de Pennsylvanie, qui fut le premier État producteur de charbon à demander une réduction des émissions de soufre dans la vallée de l'Ohio, procède actuellement à l'évaluation des dommages causés par les précipitations acides à ses lacs et à une analyse des coûts que représentent différents niveaux de réduction des émissions. Le New Jersey, qui est avant tout un État récepteur, travaille au sein de la Coalition of Northeastern Governors et du National Governors' Association pour tenter de parvenir à une solution à l'échelle nationale. Le conférencier termine son exposé en affirmant que les États de l'Atlantique-Centre appuient l'idée de réduire les émissions et d'effectuer des recherches pour mieux comprendre les problèmes reliés aux dépôts acides; il demande également au gouvernement américain d'assurer le leadership nécessaire pour mettre fin à cette menace. (E)

A REGIONAL PERSPECTIVE ON ACID RAIN: NEW YORK, PENNSYLVANIA AND NEW JERSEY

Henry G. Williams

Commissioner of the Department of Environmental Conservation
New York

Good morning! I would like to thank you for the opportunity to address this intergovernmental conference on acid rain. I have been asked to present a regional's perspective on the issue, representing the Mid-Atlantic states of New York, Pennsylvania and New Jersey. This is a large task, primarily because each state has, on its own initiative, started a major program to address this serious environmental concern. It will be impossible for me to fully discuss all the initiatives the Mid-Atlantic States have taken. Accordingly, I will use this opportunity to discuss various policy initiatives that each state has undertaken to deal with the acid deposition question.

While I choose to discuss the policy initiatives, that by no means indicates that the states have not also undertaken a major research effort to understand both the current level of effects, as well as understand fully the consequences which face us in the near future. I am submitting today copies of various reports and papiers which have been completed by each of the states. As you can see, there are a large number of them and the size would prohibit complete inclusion into any formal record which comes from these proceedings. I would, however, request that any record resulting from this conference include the title and short description for each of these publications so that all may know and understand the amount of work which has been completed by each

of the Mid-Atlantic States. Included in New York's material is a report entitled, "Acidic Deposition, Trace Contaminants and Their Indirect Human Health Effects: Research Needs." This report was just completed and I am pleased to release it today at this conference.

With that in mind, let me begin with a short background on each of the states; I will begin with my home state, New York.

Contrary to what many people believe, New York is a rural and beautiful state. Our Adirondack and Catskill Mountains are some of the best in this country and indeed in the world. We have taken measures to see that these areas are preserved in their natural form for all times. We have both an Adirondack and Catskill Park which will insure their preservation. In fact, the Adirondack Park is the largest single park in this country comprising approximately 6 million acres of rural, wild and scenic areas.

While these areas seem relatively untouched by man, they have indeed been affected by acid deposition. Currently in New York, the average rainfall has a pH of approximately 4.1. This has resulted in damage to approximately 200 lakes which are now devoid of or losing fish populations. In order to fully understand the damage that our aquatic systems have been subjected to, New York is currently surveying and analyzing 1,300 of the approximately 2,700 lakes which are contained in the Adirondacks.

Pennsylvania is unique among the states in the Mid-Atlantic region. While receiving some of the highest levels of deposition of anywhere in the northeast, Pennsylvania is also a coal producing state; and thus, as it addresses this serious concern and takes action, it does so understanding full well the potential consequences of emissions reductions to its mining industry.

At the present time, Pennsylvania's average rainfall has a pH of 4.1. In fact, there are some areas in the state where the average rainfall is below 4.0. While damages to Pennsylvania's small lakes are still being investigated and quantified, there is a more serious concern on the part of Pennsylvania's environmental officials with the damage that may be taking place in some of its pristine and beautiful fishing streams.

New Jersey, like New York, has a major metropolitan area; but also like New York, it has a large amount of rural and forested area.

In view of the fact that New Jersey is primarily a receptor state, its actions have been centered around its involvement with both the Coalition of Northeastern Governors and the National Governors' Association in an effort to achieve a national solution.

Each state has undertaken a variety of policy initiatives to deal with the acid deposition problem. Let me now review some of those actions with you.

New York:

In august of 1984, Governor Cuomo of New York signed the New York State Acid Deposition Control Act. This law, the first of its kind in the country, is designed to control and reduce New York's portion of the acid rain problem. Alone, this law will not solve the problem in New York; because on average, the state contributes only 17 percent to the problem it faces. What this act is, however, is a clear demonstration to the other states that we are serious about this problem; and we are willing, as a first step and a good faith effort, to control that portion of the problem we cause.

The acid deposition program is also an innovative approach to a control strategy. The act, as passed, does not require a certain tonnage reduction by a specific date. However, it establishes a three step process to reduce emissions in New York. First of all, it required New York to identify those areas which were highly sensitive to acid deposition. Once these sensitive receptor areas, as we call them, were identified, the second step required us to determine the appropriate deposition rate for those areas. In this case, the state has determined that these sensitive receptor areas should receive no more than 20 kilograms per hectare of wet sulfate per year, or approximately 18 lbs. per acre per year. Upon this determination, the third step required us to determine the level of reductions needed to insure that New York, through its own sources, did not violate the safe deposition rate. The law also requires that we undertake and develop a control strategy for emissions of both sulfur and nitrogen.

At the present time, we are implementing the sulfur control program as required by our legislation. Draft regulations to implement the program will be released very soon with an effective date of January 1, 1986. Once these new regulations are released, the state will then begin development of a program to limit the emissions of nitrous oxide.

Pennsylvania has also completed an analysis of the costs associated with various levels of emissions reductions. They developed a four level analysis of costs based on the various percentage reductions which have been contained in federal proposals. These increased costs range from 190 to 900 million dollars per year.

New Jersey:

In 1982 the New Jersey State Legislature passed a law which required the Governor's Science Advisory Committee to compile and issue a report on acid rain. The report required the committee to address three subject areas. First, the Committee was to review the current effects of acid rain damage. Second, it was to review current research findings; and third, it was to identify future research needs in order that the problem might be adequately addressed. This report is expected to be released in the very near future.

The bulk of New Jersey's activities, however, have been associated with its role in the Coalition of Northeastern Governors. Governor Kean has been very active in the development of CONEG'S policy statement. In 1983, the Governor was instrumental in passing the policy statement on acid rain. Recently, the Governor's efforts resulted in adoption of a zero interest loan concept to aid utilities in meeting the capital costs associated with utility retrofits for reduced emissions. Presently, New Jersey is developing the Northeast Acid Rain Research Project concept which is being designed to help meet and coordinate the research needs for the entire northeastern community.

As you can clearly see, each state supports the idea of emissions reductions to deal with this insidious form of pollution. While, as a region, we believe the time has passed for emissions reductions, we also believe additional research is needed to more fully understand the complexity of problems associated with acid deposition.

Without a doubt, we as individual states, and as a region, are doing our share in addressing this question. We ask that the Federal

Government assert the leadership needed to address and solve this environmental threat.

BIOGRAPHY

Henry G. Williams was appointed Commissioner of Environmental Conservation by Governor Mario M. Cuomo on January 10, 1983, and confirmed by the Senate on February 1, 1983.

Prior to his appointment, Henry G. Williams was Director of Statewide Strategies and Programs in the Office of the Lieutenant Governor. Between 1969 and 1979, he served as Director of the Division of State Planning, and Acting Director and Deputy Director of both the State Office of Planning Services and the State Office of Planning Coordination.

Henry G. Williams was formerly associate professor at the State University College of Environmental Science and Forestry at Syracuse from 1957 through June 1969. He taught undergraduate and graduate courses in outdoor recreation management and land use management, and conducted research in the fields of resource management, outdoor recreation policy and planning, and land use policy. Also, he has been actively involved in numerous environmental activities.

THE MID-WEST - A REGION OF DIVERSITY

Paul Guthrie
Director Intergovernmental Programs
Wisconsin Department
of Natural Resources

RÉSUMÉ

Le conférencier présente les différentes préoccupations des États du Centre-Ouest relatives aux dépôts acides, à leurs répercussions et aux stratégies visant à rectifier la situation. Pour les états de l'Ohio, de l'Indiana et de l'Illinois, tous trois producteurs de charbon, les questions de production, d'énergie électrique et de coûts d'immobilisation, de pertes des marchés du charbon et de perte subséquente de nombreux emplois dans l'exploitation minière prévalent. Les États producteurs sont très intéressés à ce que les stratégies et les technologies qui répondent aux normes nécessaires d'émissions permettent d'utiliser le charbon local. Pour les états du Wisconsin, du Michigan et du Minnesota, la menace que représentent les précipitations acides est considérée comme la plus importante préoccupation car le tourisme, la pêche et la forêt sont des ressources économiques primordiales.

La région du Centre-Ouest reçoit des précipitations fortement acides et des dépôts importants. Soixante-six pour cent des émissions d'anhydride sulfureux produites au Minnesota, au Wisconsin et au Michigan demeurent dans la sous-région. Le contrôle de la pollution atmosphérique profiterait avant tout à la sous-région. Le conférencier fait également part des études menées par l'Illinois et l'Ohio sur les problèmes environnementaux liés à l'utilisation du charbon, la technologie du charbon et les mesures prises par le Minnesota, le Michigan et le Wisconsin pour limiter les émissions d'anhydride sulfureux.

Le conférencier présente, après avoir identifié de nouvelles avenues de recherche, le consensus de la région sur la nécessité d'élaborer un programme national de réduction des émissions et de poursuivre les recherches. Les avis sont cependant partagés sur le programme de financement, la chronologie et le volume des réductions. (E)

THE MID-WEST - A REGION OF DIVERSITY

Paul Guthrie
Wisconsin Department
of Natural Resources

It is my pleasure to be here this morning to meet with you and to discuss "A Midwestern Perspective" to the topic of acid deposition.

Introduction

Let me say at the outset that while I admire those who set far reaching goals to work toward, I cannot possibly achieve the desires of our hosts:

> "Make a regional assessment of acid deposition and acidification processes, the region's sensitivity and the related effects or damage on aquatic and terrestrial (forest) ecosystems, on human health, visibility and others and their potential economic impacts for the Mid-Western States... [C]over the current and ongoing research activities (monitoring environmental survey, modeling, policy initiatives on state or regional basis) as well as the measures taken or proposed to control the acid forming pollutants."

Such an assignment could keep a team of specialists busy for months, but for me, only a few days. Nevertheless, I think I can add some information to these discussions largely due to the great help and assistance from persons in other midwestern states who have taken the time and effort to provide me with information and insights. But, while these persons have been most generous and helpful, please understand that their input has been edited by me and as such I take full responsibility for these comments.

To accomplish my assignment I have set several basic objectives for this presentation.

- To portray accurately the diverse opinions of the midwestern region as to acid deposition, its impact, threats and rectification strategy.

- To catalog generally the region's current condition as seen through data and various recent scientific studies.

- To outline topics where future study is seen as important.

- To outline current policy in the several states toward Acid Rain Legislation.

For the purposes of this discussion, the midwest is considered to be the "Great Lakes States" of Michigan, Ohio, Indiana, Illinois, Wisconsin and Minnesota. An area with 46 million people, encompassing 19 percent of the U.S. population. This region also possesses 19 percent of the United States electrical energy generating capacity and consumes 20.3 percent of the total national energy use. In this midwestern area, energy utilized comes 32 percent from coal as opposed to 18.9 percent in the balance of the country. This region has 40,000 people employed directly in coal production (130 million tons annually). 88.7 percent of all the coal mines in the region is used in the immediate region for electric power production. Other coals are also used in the region, for example in Wisconsin in 1983 in addition to the 2.9 million tons of Illinois mined coal, Montana supplied 2.5 million tons, Kentucky provided 2.1 million tons and 4.9 million tons came from Wyoming.

At the onset, one must recognize that there is no commonly held view in this region as to our topic. To characterize otherwise can only give a gross misinterpretation to the realities. Each state is different and each has different concerns that direct their view of acid deposition, its impact and implications for society.

Having said this, nevertheless, there are some generalizations that are important. The States of Ohio, Illinois and Indiana are significant producers of coal, most of which is characterized as high-sulfur. These states are large electrical generators using local coal. They are also heavily industrialized in parts of their States. Wisconsin, Minnesota, and to a large extent Michigan, are best classed as nonproducing energy users (not producers); but all the states of the region are net energy importers and as such our homes, offices, factories and transportation systems depend on the energy production of others. All of the states are major generators of electrical power.

Perceptions

The most critical aspect of the midwest's diversity is the variety of perceptions as to the facts, likely threats, suggested solutions, and state specific parochial concerns on acid rain.

To upper midwest states (Wisconsin, Michigan, Minnesota) the perceived threat to resources (air, water, forest, wildlife, etc.) is focused as the most significant and the most politically sensitive.

To the lower states (Ohio, Indiana, Illinois) the issues of electric energy production and capital costs (rate shock), loss of coal markets and the ensuing loss of many mining jobs are seen as the most critical issues.

Coal

To fully appreciate this bifurcated midwest acid rain position one must appreciate the coal dilemma and coal's prominent place in the economy of the producer states. Coal not only supplies the fuel for electric generation and creates jobs for mining, processing, transportation and delivery; but its availability has, over history, been the driving force in thousands of industrial and transportation location decisions.

A basic strategy for SO_2 emission reduction that does not in some manner permit continued use of midwestern coal, will create a series of economic and social dislocations in an area still not recovered from our most recent recessions. First, since the midwest producer states are also emitter states, emission reduction mandates will require significant retrofitting of existing facilities, at significant cost to electricity users; secondly, maintaining national emission reductions over the long-term may be most easily accomplished in some places by using lower sulfur coal (and therefore not midwestern coal) and as a result jobs in coal fields and related industries will be lost taking with them the basic economic well-being of numerous communities; and thirdly, with fuel sources changed from local sources to other areas, the local/regional economy will suffer as fuel expenditures go elsewhere. It is for this reason that the producer states are most concerned with the development of strategies and technologies that will allow the continued use of local coal, meet the necessary standards of emission control, and ameliorate economic disruptions.

Natural Resources

The second half of the midwestern schizophrenia rests also on economic terms. While as Ohio, Illinois and Indiana mine 130 million tons of coal, and have thousands of persons employed in mining and related industries, so also are economic investments at stake with regard to the region's natural resources. In Michigan, Minnesota and Wisconsin tourism, fisheries and forestry are primary economic elements. For example, Minnesota estimates that 15 percent of the forest, peat lands and watersheds in that state are sensitive to acid deposition and vulnerable to damage and economic loss. In Michigan, much of the Upper Peninsula's waters and forests are receiving significant deposition. And in economic terms in Wisconsin, where 1.5 million fishing licenses are sold annually, a fishery-tourism industry estimated at $480 million annually is at stake and in Wisconsin, more than 69,000 jobs and $1.3 billion in economic activity are based on the health of the forests of the state.

Yet to confound the issue even more, in both parts of the region (upper and lower) there are constituencies of some size on all aspects of the debate, and each has a factual basis for their point of view.

It is true, for example, that a shift away from high-sulfur coal might be an easy solution for some high emitter users. But such an outcome is not certainty, since other factors such as BTU content, shipping costs, fuel availability, burner conversion, extended life of the facility, etc. would also have to be figured into the cost effective equation.

Likewise, the presumption that all bodies of water in the state are at risk or that all forests will become stressed is not true.

Clearly some may be, some will not. Clearly many different factors beyond simple location and gross deposition must be considered.

Definitions

As an introduction to a brief discussion of current conditions in the midwest region, it would seem best to outline a few simple working definitions to guide us.

pH

pH is a chemical term used to express the effective hydrogen ion concentration in an aqueous solution. pH values range from 0 to 14 with 7.0 considered neutral and those below 7.0, acidic. Those above 7.0 are alkaline. Since pH is a logarithmic number, a change of 1.0 in pH is a ten fold change. Thus a change from 5.2 to 4.2 is a ten fold increase in acidity.

Acid Rain

Traditionnally, rainfall with a pH of less than 5.6 has been considered acidic. Such a definition has of late been considered to be too simplistic. More recently, in order to accomodate natural variations in rainfall some researchers are using a pH of 5.0 as a point where rainfall should be considered as acidic, and principally as a result of releases from man's activities. Thus by extension they consider readings below a pH of 5.0 as an unnatural condition and thereby potentially contributing to the unnatural acidification of the environment and causing unnatural environmental impacts.

Sensitivity

Simply put, the sensitivity of resources to damage from acid rain is their likelihood to be altered as a direct result of acid deposition or to change as a result of events stimulated by deposition. Generally, the best documented effects of acidification are:

- Long term pH depression of low alkalinity lakes and streams (pH 4.2-4.8).
- Episodic depression of pH during snow melts (pH 3.8-4.6).
- Increased aluminum concentrations in lakes and streams with subsequent toxic effects on fish.
- Elimination of most fish, mollusks and other benthic and planktonic invertebrates where pH values are depressed to 4.8 or lower.
- Increased uptake of mercury in predatory fish.

Susceptibility

The impact of acid deposition upon a resource is clearly a function of the amount deposited, but it is also a function of the terrain where it lands. In short, the receiving area's condition also determines the susceptibility of a particular location (or resource) to damage. Thus the interaction with vegetation, soils, geologic substrata, existing waters, etc. and otner "buffering" functions all combine to determine ultimate susceptibility.

But, the ultimate gorilla in the closet, so to speak, is the threat that at some point in time the buffering capacity of the local waters, soils, etc. will be overwhelmed by accumulated deposition and that vast areas and resources will be damaged perhaps beyond recovery, in a very short period of time.

[In a nut shell then we have the current discussion on this continent: at present the scientific evidence is that of increasing acidity, to a point in a few locations where damage is apparent and real; but to point in many places, where the rate of increase of acidity only foreshadows major problems for the future, thus stimulating a movement for deposition reduction.]

Current Conditions

Much of the public and political discussion in recent years in North America has centered upon perceived and documented damages noted in the eastern United States and Canada. (It has only been rather recently that information on western United States impacts has begun to be widely circulated.) Generally, these discussions have focused upon episodic discoveries or scientific research focusing on distinctive areas, such as higher elevations or on a particular topic such as red spruce die off, seepage lake acidity changes, etc.

For purposes of our discussions on the midwest, a more generalized summary seems in order as it provides for our purposes a more understandable perspective as to what is currently occurring.

The midwest and the northeastern parts of the United States have some of the most acidic rain and snow in the country. In our six state region, average weighted pH is about 4.4 ranging from a statewide average level of 4.6 to 5.0 in Minnesota, to 4.0 to 4.3 in Ohio. Pre-

cipitation sulfate deposition ranges from 10 kg/ha/yr in parts of Minnesota to perhaps a high of 48 kg/ha/yr in Ohio. (To some, a loading of 20 kg/ha/yr is considered the acid loading danger threshold for most localities.)

In terms of pollutant origins, models estimate that in the regions two subareas (Illinois, Indiana, Ohio; and Wisconsin, Minnesota, Michigan) that between 30 and 40 percent of all SO_2 received in the subregion originated out of the three state area.

In 1980 the six state region generated 7.9 million tons of SO_2, and 4.4 million tons of NO_x or 29.9 percent and 20.7 percent of the national emission load. In the past three decades, pH levels of rainfall have shown significant flux with acidity increasing steadily between 1950 and 1970, and then they apparently began to stabilize.

Between 1940 and 1980, SO_2 emissions in the regions increased 50 percent. From 1970 to 1980 emissions for the region declined slightly (10 percent). Between 1940 and 1980, NO_x emissions were up 300 percent. In the 1970's a 10 percent reduction was noted.

Table 1

Midwest Summary

Michigan

Emission data: SO_2 - 904,000 tons (1980)

NO_x - (From utilities 564,000 tons)

- 690,000 tons

Deposition: 44 percent received from outside of WI, MN, MI

Rainfall (Weighted Annual Av) pH 4.4 (1981)

Sulfate Deposition (wet): 10 to 47 kg/ha/yr

Minnesota

Emission data: SO_2 - 259,303 tons (1980)
(From utilities 168,980 tons)
NO_x - 373,000 tons
Deposition: 44 percent received from outside of WI, MN, MI
Rainfall (W.A.A.): pH 4.6 to 5.0
Sulfate Deposition (wet): 13.4 to 29 kg/ha/yr

Wisconsin

Emission data: SO_2 - 637,000 tons (1980)
(From utilities 485,700 tons)
NO_x - 420,000 tons
Deposition: 44 percent received from outside of WI, MN, MI
Rainfall (W.A.A.): pH 4.8 (North and West)
4.6 (North Central)
4.4 (South and East)
Sulfate Deposition (wet): 10 to 14 kg/ha/yr (North and West)
11 to 16 kg/ha/yr (North Central)
24 to 33 kg/ha/yr (South and East)

Illinois

Emission data: SO_2 - 1,471,000 tons (1980)
(From utilities 1,125,000 tons)
NO_x - 1,005,000 tons
Deposition: 27 percent received from outside of IL, IN and OH)
Rainfall (W.A.A.): pH 4.2 to 4.5
Sulfate Deposition (wet): 22 to 38 kg/ha/yr

Indiana

Emission data: SO_2 - 2,008,000 tons (1980)
(From utilities 1,539,000 tons)
NO_x - 773,000 tons
Deposition: 27 percent received from outside of IL, IN, OH
Rainfall (W.A.A.): pH 4.2
Sulfate Deposition (wet): 29 to 38 kg/ha/yr

Ohio

Emission data: SO_2 - 2,647,000 tons (1980)
(From utilities 2,171,600 tons)
NO_x - 1,145,000 tons
Deposition: 27 percent received from outside of IL, IN, OH
Rainfall (W.A.A.): pH 4.0 to 4.3
Sulfate Deposition (wet): 29 to 48 kg/ha/yr

Table 1 outlines state by state specific data on emissions, deposition, and pH.

Transportation

There are perhaps as many models to estimate regional transportation of SO_2 as there are theories of the mechanics. However, a couple provide some very general insights into the controversy of who emits and where it goes. Table 2 shows a simplistic summary of one.

Table 2
(1979 Data)

Sending Region	percentage of Total Deposition			
1	42	7	0	4
2	13	44	14	5
3	7	22	57	18
4	38	27	28	74
Receiving Region:	1	2	3	4

In Region #1 (New York, Pennsylvania, New Jersey, Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermont and Maine) 42 percent is self generated, 38 percent is from Region IV (our six state region plus westward territory). Region 2 (Maryland, Delaware, Virginia, West Virginia, North Carolina, South Carolina, Georgia and Florida) receives 44 percent from its own sources, 22 percent from Region III and 27 percent from Region IV.

Table 3

Annual Interregional Exchanges Between Midwest Regions (2) and (7) and Other Areas of North America (1977 Data)

Receiving Regions	Kilotons Transported From			Percentage of Total Deposition Received From		
	Region 2	Region 7	TOTAL	Region 2	Region 7	TOTAL
1 (Dakotas West)	3	2	5	19	9	28
2 (Minn, Wi, Mich)	655	186	841	66	19	86
3 (South Ontario)	290	145	435	19	10	29
4 (Mo, Iowa, Ks, Nb)	46	135	181	7	22	29
5 (Colo, Wyo, etc.)	0	0	0	0	1	1
6 (Texas, Ark, LA, Okla, etc.)	3	14	17	1	3	4
7 (Ill, Ind, Ohio)	229	1566	1795	9	65	74
8 (Miss, Ala, Ga, Fla)	6	59	65	0	5	5
9 (Ky, Tn, NC, SC)	24	425	449	1	23	24
10 (Pa, WVA, Va, Md, Del)	78	520	598	3	23	6
11 (NY, NJ)	50	92	142	7	13	20
12 (Me, NH, Vt, Mass, Conn, RI)	18	30	48	4	6	10
13 (South Quebec)	23	26	49	6	6	12

Adopted From: Interregional Exchanges of Air Pollution: Model Types and Applications; Warren B. Johnson, Journal Air Pollution Control Assoc. June 1983, Vol. 33 #6 pg. 569.

A second model, segmented somewhat differently, shows similar results. (See Table 3).

All transportation models are subject to justifiable concern as to their preciseness of prediction because of the complexities of the factors involved. For our general purposes, they make several critical additions to our discussions.

First, in any one region, the largest single amount of deposition is self generated, and secondly, that depended upon location etc., significant and important amounts are also transported to other places. Thus while 66 percent of the SO_2 generated in Minnesota, Wisconsin and Michigan is left in the subregion, 9 percent may make its way to Illinois, Indiana and Ohio, 7 percent to New York and New Jersey or 6 percent to Québec.

Thus in controlling air pollution emissions in our midwest, the most dramatic and important changes will be noted in our own conditions and in our own loadings and in our own depositions.

Damages

For this report our host asked us to outline damages. This is a somewhat ambitious assumption since much of the investigation and must of the current scientific inquiry now going on is focused on detailing what has happened and what may happen. I will not attempt to repeat many of the well known comments and well known papers that have been made public in the last few years. But I will list just a few items which I think point out that the midwest is no different from other places. Clearly in the midwest we do not have such publicly visible and emotionally documented damages as are present in Germany, or eastern Europe or Scandinavia. Nor do we have our localized monuments to recount historical airborne damage such as can be seen in Sudbury, Ontario or Copperhill, Tennessee.

We do have suspicions and we do have concerns. For example, studies carried out over the last few years by personnel of the U.S. Forest Service, on National Forest Lands in Minnesota, Wisconsin and Michigan suggest that in studied lakes deficiencies in alkalinity and sulfate concentrations in excess of background levels are in direct proportion to precipitation acidity. Ten percent of the sampled lakes in northeastern Wisconsin and upper Michigan were found acidic.

In another instance, studies on air pollution toxicity to eastern White Pine in Indiana and Wisconsin show injury in both urban and rural settings from ozone and SO_2. And in another study, deciduous trees in the Ohio valley have shown a marked narrowing of annual growth rings beginning in the mid 1960's, and they have displayed foliage symptoms typical of ozone and acid aerosol effects.

On the other hand, a recent paper on Wisconsin forest soils, while expressing the need for further research found no direct damage to be attributed to acidic deposition, and further found that some of Wisconsin's most sensitive soils do appear to be capable of neutralizing existing deposition.

Recent studies by the Wisconsin Department of Natural Resources, using "water chemistry fingerprinting" is showing in 11 test seepage lakes, a composition of ions more similar to the chemistry of precipitation rather than to "normal lake concentrations" thus suggesting that acidity in these lakes is directly caused by acid rain.

Further analysis by the Department of Natural Resources is focused on three lakes where predatory fish have been identified as having elevated levels of mercury (above the 1.0 ppm federal human consumption standard). Other studies suggest that sources of this mercury may be as much air borne disposition as the unlocking of mercury from surrounding soils.

Finally, one intriguing challenge: recent evidence collected on post mortems done on loons from a massive die-off in the southeastern United States in the winter of 1984, points to mercury poisoning as the primary cause. Because of the general lack of data on loons, their migration patterns, etc., it is not at this time possible to identify the sources of the mercury. Speculation is centered on the consumption of mercury laden fish. Interest has been expressed in tracking this loon mortality back to specific areas to see if acid impacted, mercury laden lakes were involved.

Current Activities

I was also asked to outline recent activities by midwest states relative to acid rain. For reasons of research time and limited information, I can only outline a few events, but they seem to provide a flavor of current actions and activity in the region.

In Illinois, state government has taken the lead in promoting research and development programs aimed at solving environmental problems relating to the use of Illinois coal. To date:

- 6 million dollars in basic research on chemical techniques for removing sulfur and other impurities has been undertaken.

- 56 million dollars in capital support for full scale clean coal utilization demonstration programs has been committed.

- An additional 55 million dollars in revolving loan program monies for industries to convert to coal has been begun.

- A tax incentive for industrial investment in coal research and equipment for the use of Illinois coal has also been started.

- Ongoing research by state agencies, the University of Illinois and the Argonne National Laboratory on Illinois specific issues of acid rain and plant life are continuing.

In Ohio, major emphasis has also been on matters of air pollution and coal technology.

- The Ohio Environmental Protection Agency has made a major push at eliminating enforcement violation backlogs in its air enforcement program.

- Between 1975 and 1985, 740,000 tons of SO_2 emissions have been cut.

- Increased funding for coal development so as to accelerate proper investment in near commercial technology for the clean burning of Ohio coal has been undertaken.

- There has been established a coordinated research program in coal development.

- Ohio in cosponsorship with the U.S. EPA and private groups, has initiated a 100 megawatt LIMB demonstration project at Ohio Edisons's Edgewater facility in order to demonstrate the large scale feasibility of this process.

- A 100 million dollars coal research and development program is on the fall ballot for Ohio voters in 1985.

- The state government has been promoting new technologies in the improvement of coal and clean coal performance.

- There has been established in Ohio a coal development office which among other priorities is trying to improve environmental quality via the use of cleaner coal and cleaner coal combustion.

In Michigan:

- SO_2 emissions have been reduced by 794,560 tons between 1975 and 1980.

- 342,000 tons of NO_x emissions were also cut in this same period of time.

- As of 1985, all major plant emissions within Michigan will meet the 1 percent sulfur and fuel limitation of the Clean Air Act.

In Minnesota:

- The State of Minnesota adopted the Minnesota Acid Deposition Control Act which is to be fully implemented by January 1986 and calls for the identification of sensitive resources, current depositions and the adoption of deposition standards to obtain compliance statewide.

- Since 1974, SO_2 emissions have been reduced by 30 percent to a statewide average of 1.5 pounds per million BTUs.

- The state is conducting a thorough soil and watershed acidification study designed to evaluate the sensitivity of Minnesota soils to acid deposition and to estimate rates of acidification.

In Wisconsin a state law was recently adopted limiting total utility SO_2 emissions. This law also required joint annual operating plans of major utilities to provide details and information on how the utilities plan to limit annual emissions and it established an acid deposition review committee for the purpose of studying progress to the goals of the act and to evaluate acid rain and its impacts on the state.

- The Department of Natural Resources recently adc ted amendments to its Administrative Regulation (NR 154.12) to further protect human health from sulfur emissions by limiting individual emissions.

- There has been more than 2 million dollars invested in acid rain research in the last four years.

- Numerous studies on acid rain related activities have been undertaken including the deposition monitoring, data quality assurance, atmospheric trajectory studies, emission source identification, intensive watershed studies, aquatic resources susceptibility and the artificial acidification of a test lake.

Future Research Ideas

Clearly, there are massive amounts of research that can and should be undertaken. One of the things that has impressed me the most is the almost endless array of topics that are suggested for investigation. Almost any learned journal article or symposia summary enumerates a long list of new projects and new concepts for investigation. From these, one can draw a few items that seem especially appropriate with regard to the midwest condition.

- Clearly, forestry impacts in the midwest needs much more work. Investigation needs to be done on direct and indirect impacts and the relationship of those impacts on a variety of species in both urban and rural settings.

- More investigation and upscale implementation needs to be done on methods of cleaning high-sulfur coal, both to be able to utilize such coals and to develop cheaper, more efficient systems of emission reduction.

- Works needs to be expanded into potential long-term crop damage, especially with regard to grains. (This seems to be an important area given the recent european reports indicating crop impacts as an outgrowth of air deposition.)

- More research is needed into actual acidity trends and in establishing baseline data to assist in future research.

- More work is needed in identifying the sensitivity and susceptibility of lands and waters to given levels of deposition and to potential mitigation measures.

- More research is needed on air transport issues and the vagaries of source and receptor relationships.

- Total watershed chemical balances and the influence on surface waters ought to be worked upon.

- Increased investigation in human health impacts associated with heightened sulfate in ambient air is also a needed exercise.

- Work needs to be carried out swiftly into the apparent explosion of mercury related problems that are now becoming apparent, especially in the upper midwest.

National Policy

As a closure to this somewhat arbitrary assortment of midwest facts, a few comments about national policy seem in order.

Surprisingly, despite the bifurcated nature of the midwest view, there are some common elements to a midwest concept of national acid rain legislation.

First and foremost there is, I believe, conceptual agreement that there needs to be national legislation. All agree that individual states or provinces working by themselves cannot sufficiently control the pollutants in their own or any other area to succeed in reducing total emissions to a point that is effective for the long haul.

Secondly, all states believe that the required methods of emission reduction that involve mechanical approaches should be flexible enough to allow for true competitive enterprise, hopefully affording more efficient solutions. All states, I believe, agree that any national legislation should allow for changes in the national prescription over time, if changing circumstances or information establishes its veracity.

All the states believe that research should continue on all aspects of the problem, ranging from fuel technology, to boiler designs, to water impacts and sensitivity, to agricultural and forest products, to damage mitigation.

There is disagreement as to whether a national program ought to have a financing plan for capital and maintenance costs; how those funds should be raised and how they should be distributed. While a "polluter pays" theorem is noted by some of the states, I believe all would endorse equitable national cost sharing if that was necessary for a national consensus.

There is disagreement in the region as to whether fuel switching should be authorized as a credited method of emission control and reduction.

And there is some disagreement as to the timing of emission cuts and how much of a tonnage reduction should be nationally promoted.

But there appears to be a subtle, perhaps inarticulated consensus that not enough national leadership has been forthcoming either in the race to develop technology for emission reductions or in establishing a national objective for all to work toward.

Conclusion

Finally, a personal comment. As a layman in reviewing the mountains of materials on the subject of acid rain, one cannot help but be struck with one overriding observation.

First, one is immediately overwhelmed by the almost dogged disagreement that seems to follow the topic. Acid rain to some has become almost as a religion. Once you have converted to one point of view or another, once you have accepted the faith, you defend your point of view against all challenges both substantive and not. The drive of blind faith is in some cases blinding us to several key points.

From all of the evidence around us, in Europe, in Canada, in the Rocky Mountains, on Camels Hump, on Mount Mitchell, or in the waters of the northern midwest or in the trees of the Ohio valley, we see changes occurring, and these changes are a problem to life as we know it. And in all likelihood, these changes are the result of air deposition, instituted by the acts of man and most likely by the combustion of fossil fuels.

What you find when you cut through all of the rhetoric is not that we disagree over there being a problem, but rather that we disagree on how big it is, how serious it is, and what ought to be done about it. Perhaps more seriously, we seek to find out how long we have before our problem turns into a disaster. As a result, we find ourselves working on the margins of the issue, defining the circumstances and the quantity, but not committing ourselves to the central challenge, the needed national and international coordinated effort of limiting the air pollutants issuing from our industrial societies.

BIOGRAPHY

Paul Newman Guthrie Jr., as Director of the Office of Intergovernmental Programs, is responsible for the direction of federal grant program activities carried out by the Department, for the supervision of assistance programs to local government and serves as the Department's liaison to federal agencies.

These responsibilities include serving as State Outdoor Recreation Liaison Officer for the past nine years, upon appointment by four Governors: Managing Land and Water Conservation Grant programs; Managing the Wisconsin State Municipal Wastewater Construction Grants Program, incorporating both federal and state financing, constituting the largest public works program in the State's history.

In addition to departmental assignments, current responsibilities include representing the Governor of Wisconsin as staff representative to the National Governors' Association's Committee on Energy and Environment, serving currently as staff chair; membership on the State U.S. EPA Operations Task Force; and serving as co-chairman of the State/Local/EPA Liaison Group on Groundwater Protection.

INITIATIVES DES PROVINCES DE L'EST DU CANADA EN MATIÈRE DE PRÉCIPITATIONS ACIDES

Jean Piette
Directeur des stratégie et politiques environnementales
Ministère de l'Environnement du Québec

ABSTRACT

The conference gives a full account of the situation in Canadian provinces from Manitoba to Newfoundland and shows the urgency in taking measures to fight acid precipitation. The high level of precipitation acidity, the vulnerability of the environment, the change in the quality of lake water and streams, damages to fish populations, the alarming dieback of maple stands in southern Québec have all forced the federal and provincial governments into developing and undertaking an emissions reduction program. On February the 5th, 1984, the various ministers of Environment each claimed a share in the abatement effort. Thus the provinces were committed to reducing Canadian sulfur dioxide emissions by 50 percent by 1994. The total estimated cost of this abatement program is 600 million to 1 billion dollars. In the following weeks, the federal government pledged to support the reduction measures through a subsidy program and also proposed new legislative measures, concerning motor vehicles, which should come into effect on September 1, 1987. As for Québec, it adopted a regulation on February 6, 1985, that will allow it to reach its reduction goal of 45 percent by 1990.

However, the problem of acid precipitation cannot be solved without American contribution. Sources of emissions in the U.S. contribute as much as 50 percent of acidic depositions in certain receptor areas of Québec and Ontario and up to 60 percent in the Maritimes. Such mutual

dependence has prompted many provinces to cooperate with neighbouring states and to give their support to the federal government in its discussions with the American government. Canadian provinces agree that a high degree of cooperation between regions, states and provinces, and between countries, would be necessary to solve the acid precipitation problem.

INITIATIVES DES PROVINCES DE L'EST DU CANADA EN MATIÈRE DE PRÉCIPITATIONS ACIDES

Jean Piette
Ministère de l'Environnement du Québec

Nos inquiétudes et l'urgence d'amorcer immédiatement des mesures pour combattre les précipitations acides nous ont incité à vous présenter un portrait précis et complet de la situation des provinces de l'Est. Les gouvernements provinciaux se sont engagés de façon non équivoque à prendre toutes les mesures pour lutter contre ce problème dans tous les domaines de leur compétence.

Voici donc les initiatives des gouvernements du Manitoba, de l'Ontario, du Québec, du Nouveau-Brunswick, de la Nouvelle-Écosse, de Terre-Neuve et de l'Île-du-Prince-Édouard en matière de précipitations acides.

Réseau de mesure

Dans chacune des provinces, les eaux de précipitation font l'objet d'une surveillance permanente et systématique au moyen de stations de mesures particulières.

Les réseaux provinciaux mis sur pied comprennent cinq stations au Manitoba, 36 en Ontario, 46 au Québec, trois au Nouveau-Brunswick, cinq en Nouvelle-Écosse et trois à Terre-Neuve. Un réseau (CAPMON) exploité par le gouvernement fédéral, dont les 19 stations sont réparties dans ces différentes provinces s'ajoute à ces derniers.

Ces réseaux permettent de recueillir les données de base sur la distribution spatiale des précipitations acides et d'en suivre l'évolution temporelle à long terme.

La densité de l'ensemble des stations et leur répartition sur l'ensemble du territoire, s'étendant du Manitoba jusqu'à Terre-Neuve, permettent d'identifier l'importance des précipitations acides ainsi que les zones les plus touchées par les dépôts dans chacune des provinces.

Les valeurs de pH et des dépôts humides de sulfate sont, parmi les paramètres analysés, ceux qui mettent le plus en relief l'importance de l'acidité des précipitations de ces territoires.

Les résultats obtenus au cours de 1980 à 1983 sont utilisés pour dégager un portrait de l'acidité des précipitations pour l'Est du Canada.

Les résultats obtenus indiquent que le Manitoba est très peu affecté par les précipitations acides puisque la valeur moyenne annuelle de pH est en général supérieure à 5,0 et que les dépôts humides de sulfate maximum observés ont été de 10 kg/ha/an.

Le pH moyen annuel enregistré au sud de l'Ontario est de 4,2 et on constate que toute la partie sud du lac Supérieur reçoit des dépôts humides de sulfate à un niveau potentiellement dommageable aux milieux aquatiques sensibles. Des valeurs de 28 à 45 kg/ha/an y ont été mesurées et les concentrations de sulfate sont trois fois plus élevées que celles retrouvées dans le nord de la province.

Le patron général qui se dégage des données obtenues montre une variation des valeurs selon un gradient négatif suivant un axe sud-nord pour le sud et le centre de l'Ontario; ce gradient est plus du sud-est - nord-ouest dans le nord de l'Ontario.

Pour une grande partie du sud et du sud-ouest du Québec, une moyenne de pH de 4,3 y est relevée et les dépôts humides de sulfate varient entre 25 et 40 kg/ha/an. Le niveau d'acidité le plus élevé se retrouve dans la région immédiate de Québec. Ces données confirment le haut niveau d'acidité des précipitations sur le territoire québécois.

Les valeurs se répartissent sur le territoire selon un gradient décroissant du sud-ouest au nord-est. La concentration des sulfates y varie par un facteur 3. Au nord du 52^{e} parallèle, on mesure des dépôts de sulfate de 9 kg/ha/an et une valeur de pH près de 4,8.

Au Nouveau-Brunswick, les valeurs moyennes annuelles de pH varient entre 4,2 et 5,4 et les niveaux de sulfate humide se situent entre 16 et 23 kg/ha/an. Les valeurs les plus élevées se retrouvent au sud-ouest de la province.

En Nouvelle-Écosse, comme au Nouveau-Brunswick, le niveau le plus élevé d'acidité dans les précipitations est mesuré au sud-ouest du territoire. Le long de la baie de Fundy, la valeur moyenne annuelle de pH se situe à 4,5 et le niveau de sulfate humide à 23 kg/ha/an en moyenne.

L'acidité des dépôts diminue graduellement du sud-ouest au nord-est. Ainsi, on retrouve au Cap Breton, situé au nord de la province, une valeur moyenne de pH de 5,0 et des dépôts de 17 kg/ha/an.

Les dépôts les plus élevés de sulfate se retrouvent dans une zone restreinte près de Halifax, où les sources locales d'émissions de SO_2 représentent environ 28 pour cent des rejets en provenance de cette province.

Comme pour les autres provinces de l'Atlantique, la côte sud et la région sud-ouest du territoire de Terre-Neuve reçoivent les précipitations les plus acides. La valeur moyenne de pH est de 4,5, tandis que plus au nord, les valeurs sont supérieures à 4,8. Quant aux dépôts humides de sulfate, le niveau le plus élevé atteint près de 20 kg/ha/an pour diminuer par la suite jusqu'à 15 kg/ha/an.

Aucune station de mesure ne dessert le territoire de l'Île-du-Prince-Édouard. Cependant, les résultats obtenus pour le nord de la Nouvelle-Écosse et du Nouveau-Brunswick donnent de bonnes indications de ce que pourraient être la valeur du pH (autour de 5,0) et le niveau de sulfate humide (autour de 16,0 kg/ha/an).

L'ensemble de ces données sur les eaux de précipitations provenant de différents réseaux provinciaux met en relief l'importance des précipitations acides et la menace qu'elles constituent pour les écosystèmes récepteurs pour tout l'est du Canada, à l'exception du Manitoba et de l'Île-du-Prince-Édouard.

Sur une grande partie des territoires ontariens et québécois, les valeurs moyennes annuelles de pH confirment le haut niveau d'acidité des précipitations, lesquelles sont de 20 et 25 fois plus acides qu'une précipitation considérée normale.

Des régions importantes, notamment le sud de l'Ontario et du Québec, sont parmi les zones les plus exposées du nord-est de l'Amérique du Nord. Le sud-ouest du Nouveau-Brunswick et de la Nouvelle-Écosse

reçoivent aussi des dépôts humides de sulfate supérieurs à 20 kg/ha/an, niveau retenu comme limite pour assurer une protection adéquate des écosystèmes aquatiques modérément sensibles.

L'ensemble de la répartition spatiale des valeurs obtenues indique:

- que les sources extérieures sont celles qui influencent la qualité des précipitations dans le cas des provinces de l'Atlantique, à l'exception d'une zone très limitée de la Nouvelle-Écosse;

- dans le cas de l'Ontario et du Québec, les gradients décroissants des dépôts de sulfate, selon la direction sud-nord dans le premier cas et sud-ouest - nord-est dans le second, indiquent respectivement une contribution importante des sources situées au sud de l'Ontario (États-Unis) pour l'Ontario et, au sud-ouest du Québec (Ontario et États-Unis), auxquelles se superpose régionalement la contribution de sources locales, démontrant ainsi la réalité du transport des polluants à grande distance.

De façon générale, les mesures indiquent que les concentrations de sulfate sont plus de deux fois supérieures aux concentrations de nitrate. Il est à noter aussi que ce sont les sulfates qui contribuent à l'acidification à long terme, les nitrates étant en majeure partie retenus par la végétation dans les bassins versants et ne s'accumulant pas dans les eaux de surface.

Sensibilité à l'acidification

Les dépôts acides auxquels les ressources sont exposées ne constituent pas le seul facteur déterminant quant aux risques que représente la pollution transfrontalière. La sensibilité de telles ressources à ces dépôts et les caractéristiques de l'environnement où elles se développent sont d'autres facteurs aussi importants.

La géologie de la roche-mère et des sols indique la sensibilité des écosystèmes terrestres et aide aussi à déterminer la susceptibilité des eaux de surface à l'acidification.

En effet, la capacité à neutraliser l'acidité dans les écosystèmes aquatiques ou terrestres provient de la désagrégation ou la dissolution de la roche-mère et des sols. Par conséquent leur examen peut fournir une indication de la capacité d'un territoire à résister à des dépôts acides élevés.

Se basant sur les sols prédominants et les caractéristiques géologiques pour chacune des provinces, on a pu évaluer que les régions les plus sensibles sont celles situées sur le bouclier précambrien, soit le nord-est du Manitoba, le sud-ouest et le centre de l'Ontario ainsi que la majeure partie du territoire québécois, et les grandes régions de Terre-Neuve, du sud-ouest de la Nouvelle-Écosse, du sud-ouest et du centre nord du Nouveau-Brunswick.

D'autres données sont aussi disponibles pour préciser davantage la sensibilité des eaux de surface aux dépôts acides. En effet, lors de différentes études des eaux de surface, on a mesuré l'alcalinité de l'eau, paramètre représentant la capacité tampon de l'eau et reflétant sa vulnérabilité à l'acidification. Plusieurs données sont aussi disponibles en ce qui concerne les pH de l'eau.

En Ontario, une étude de plus de 4000 lacs indique que quatre pour cent de ces lacs sont acidifiés à un degré tel que leur capacité à soutenir la vie aquatique est sévèrement limitée. De plus, 13 pour cent de ces lacs sont extrêmement sensibles et plus de 41 pour cent sont considérés modérément sensibles, tandis que 24 pour cent ne seraient pas sensibles aux effets cumulatifs des précipitations acides.

Pour le Québec, une étude similaire révèle que sur 600 lacs étudiés, plus de 21 pour cent sont déjà acidifiés, 31 pour cent se classent comme extrêmement sensibles et 14 pour cent comme modérément sensibles. La majeure partie du territoire québécois repose sur une roche-mère composée principalement de granite et de quartz, recouverte par une mince couche de sol, caractéristique propre au bouclier canadien.

Une grande partie de la Nouvelle-Écosse est composée de granite et de quartz et les relevés effectués en été dans 247 lacs, pour la plupart situés sur une telle géologie, ont démontré que 45 pour cent des lacs échantillonnés avaient moins de 20 uéq/l d'alcalinité; 16 pour cent des lacs échantillonnés n'avaient même pas d'alcalinité mesurable.

D'autres études établissent que dans certaines parties de Terre-Neuve, dans le sud-ouest et le centre nord du Nouveau-Brunswick, on retrouve des lacs et des rivières sensibles aux précipitations acides.

Il apparaît donc qu'on retrouve un nombre important de lacs vulnérables, notamment en Ontario et au Québec. Comme ces régions reçoivent des niveaux de dépôts acides élevés, des effets devraient se manifester dans plusieurs lacs et rivières.

Effets sur les écosystèmes aquatiques

Jusqu'à tout récemment, les dommages subis par les milieux aquatiques et la disparition ou le déclin des populations de poissons représentaient la principale préoccupation liée aux précipitations acides. Les études et les recherches, ici comme dans la majorité des pays, touchent principalement le domaine aquatique, de sorte que l'aspect des dommages aux écosystèmes aquatiques par les dépôts acides demeure le mieux documenté et compris.

Les études et recherches réalisées par les provinces et le fédéral démontrent d'importants changements dans la qualité de l'eau des lacs et des rivières qui ont une influence néfaste sur certains écosystèmes aquatiques.

Ainsi, on a décelé des baisses significatives de pH et des valeurs importantes de sulfate et même des augmentations de concentration de métaux dans certains cas. Il existe une corrélation étroite entre cette dégradation de la qualité de l'eau et les précipitations acides.

La dégradation de la chimie des eaux de surface a été démontrée par des études réalisées dans plusieurs provinces, et on peut conclure:

- qu'en Ontario, l'acide sulfurique est la cause de l'acidification à long terme des eaux de surface;

- que dans les zones plus vulnérables, l'augmentation des niveaux de sulfate est accompagnée d'une réduction correspondante de l'alcalinité et du pH. Dans les lacs où les valeurs de pH sont faibles, le sulfate est l'anion dominant.

Au Québec, les études sur la qualité de l'eau des lacs réalisées depuis 1980, ont donné des résultats similaires:

- Dans les lacs du sud du Québec, les concentrations de sulfate sont de deux à six fois plus élevées que celles observées au nord du 50e parallèle, avec des valeurs maximales dans les régions de l'Outaouais et dans la vallée du Saint-Laurent. Des valeurs élevées se retrouvent aussi dans certains lacs de la région de l'Abitibi qui subissent l'influence de la plus importante source locale d'anhydride sulfureux au Québec.

  Mis à part certains points chauds, on note une diminution graduelle des sulfates dans les lacs du sud-ouest au nord-est. Cette distribution de sulfate dans les lacs présente une très grande similitude avec la distribution spatiale des dépôts de sulfate associés aux précipitations acides.

  Ces concentrations élevées de sulfate (atteignant 180 uéq/l) peuvent être expliquées par l'apport atmosphérique des précipitations acides seulement et non par une contribution géologique (évaluée à environ 30 uéq/l).

  En se basant sur les valeurs de pH, 28 pour cent des lacs échantillonnés et présentant un pH inférieur à 5,5 sont considérés acides. La teneur en sulfate de ces lacs équivaut à au moins trois fois le niveau naturel.

- La concentration totale d'aluminium est beaucoup plus élevée (moyenne 230 uq/l) pour la plupart des lacs à faible pH comparativement aux lacs à pH plus élevé (moyenne 71 uq/l).

- Au Nouveau-Brunswick, l'étude de certains lacs montre une baisse de pH par rapport au niveau mesuré pour la période de 15 à 20 ans antérieure à l'apparition des précipitations acides dans la région.

- En Nouvelle-Écosse, une étude portant sur l'acidification des lacs indique à nouveau que les concentrations de sulfate dans les lacs pour différentes régions de la province semblent suivre une répartition qui s'apparente à celle des dépôts atmosphériques, malgré les différences chimiques et physiques dans les bassins versants et les processus atmosphériques. De plus, les comparaisons des valeurs de pH pour une série de dix lacs échantillonnés à nouveau après une période de 22 ans indiqueraient une réduction appréciable du pH pour les lacs les plus alcalins.

- À Terre-Neuve, des études récentes de certains cours d'eau nous laissent croire qu'il n'y aurait pas de répercussion majeure observable à l'exception d'un ou deux cours d'eau situés sur le côté sud de la province où il y a eu augmentation de l'acidité. Par conséquent, il n'existe pas d'acidification importante des eaux de surface dans cette province. De tels résultats s'expliquent par le fait que malgré l'existence de certaines zones sensibles, les dépôts acides (de près de 20 kg/ha/an et moins) qu'elles reçoivent, ne sont pas suffisamment élevés pour altérer la qualité des eaux.

Outre ces importants résultats sur l'influence de l'acidité sur la qualité des eaux de surface, de multiples données ont été recueillies sur la répercussion de l'acidification sur les différents

organismes aquatiques, notamment le poisson. De telles données existent en particulier pour l'Ontario, le Québec et la Nouvelle-Écosse.

Ainsi, en Ontario, les différentes données recueillies jusqu'à maintenant indiquent:

- que les charges acides actuelles causent des dommages aux populations de poisson et aux autres organismes dus aux chutes de pH provoquées par la fonte printanière;

- que les populations de meunier noir sont affectées à un pH se situant entre 5,7 et 6,3;

- que la truite est disparue dans les lacs les plus acides (pH 5,2) et qu'il y aurait des problèmes persistants de recrutement dans les lacs de pH inférieurs à 5,5.

- L'acidification des lacs est accompagnée par la diminution d'espèces planctoniques, par des changements dans l'occurrence et l'abondance de zooplancton et des réductions de la diversité et de la biomasse des communautés de zooplancton, ce qui peut avoir des implications importantes pour les organismes plus élevés dans la chaîne alimentaire.

Au Québec, des études ont aussi démontré que le niveau d'acidité de certains plans d'eau a induit des modifications sur la faune piscicole.

Des résultats recueillis à ce jour, on peut dégager les conclusions suivantes:

- la densité des populations d'omble de fontaine est beaucoup plus faible dans les lacs acides (5,5) que dans les lacs plus alcalins, affectant ainsi l'exploitation de la pêche sportive;

- certaines anomalies, reliées à l'aluminium dissous par l'acidité des précipitations et déposé sur les branchies de poissons, ont été décelées;

- trois lacs de la région de Charlevoix sont dépourvus de population d'omble de fontaine et leur disparition est directement reliée à l'acidité des lacs (pH 5);

- les résultats obtenus de l'étude d'un certain nombre de lacs démontrent l'existence d'un lien direct entre l'acidité de l'eau et le nombre d'espèces de poissons présents dans ces lacs. Deux des lacs examinés sont dépourvus de poissons et seulement quelques espèces telle la perchaude tolèrent des niveaux de pH inférieurs à 5,2, bien que la densité de population soit plus faible par rapport aux lacs alcalins;

En Nouvelle-Écosse, 10 pour cent des rivières à saumon seraient impropres au saumon et 20 pour cent seraient menacées.

Les résultats disponibles présentement sur les écosystèmes aquatiques indiquent que:

- pour une très grande partie de l'immense territoire s'étendant de l'Ontario jusqu'à Terre-neuve, à l'exception de l'Île-du-Prince-Édouard, soit une zone d'environ un million de milles carrés, la qualité des eaux de surface a

subi des changements marqués tels que la chute de pH, l'augmentation de sulfate et la réduction de l'alcalinité. Certains lacs et rivières montrent des signes critiques d'une réduction très importante de leur capacité de neutralisation;

- les organismes aquatiques ont aussi été affectés par l'acidification due aux précipitations acides; en Ontario, au Québec et en Nouvelle-Écosse on a relevé des problèmes de recrutement, des réductions de la densité des populations de poisson et d'autres organismes, différentes anomalies décelées chez le poisson, et même la disparition de certaines espèces de poissons dans certains lacs et rivières.

Les informations obtenues démontrent que, pour une multitude de plans d'eau, le niveau de dépôt actuel cause des effets chimiques et biologiques et que cette situation continuera à moins de réductions importantes des dépôts acides auxquels ils sont exposés.

Effets sur les écosystèmes forestiers

Récemment, les préoccupations relatives aux dommages occasionnés par les précipitations acides se sont accentuées à la suite du déclin de la productivité de certaines forêts et de la mortalité importante d'arbres dans des zones affectées par un taux élevé de pollution.

Il nous apparaît que le problème crucial que pose le dépérissement progressif des forêts, notamment en Allemagne de l'Ouest, et qui se manifeste presque simultanément en différents lieux de l'Europe centrale et de l'est de l'Amérique du Nord depuis trois ans, indique qu'on a pu surestimer la capacité de tolérance des écosystèmes

forestiers et leur capacité d'adaptation à un environnement fortement altéré, notamment par les précipitations acides.

Le problème du dépérissement des forêts est aussi important pour la majorité des provinces, d'autant plus qu'au Québec et en Ontario, on observe des signes inquiétants de dépérissement chez les feuillus dans certaines zones caractérisées par des taux élevés de dépôts acides.

Ainsi, les études effectuées depuis 1982 dans une région située au sud de la ville de Québec ont permis de constater le dépérissement de la forêt dont les symptômes se présentaient par:

- le déploiement de feuilles plus petites et plus pâles
- le ralentissement du taux de croissance
- le décollement de l'écorce sur les branches et le tronc.

Le dépérissement a été observé sur des peuplements constitués de feuillus tels l'érable à sucre, l'érable rouge, le bouleau jaune et le hêtre. Tout porte à croire que les peuplements mélangés et les résineux seraient aussi affectés.

Dans le cas du groupement le plus affecté (érablière à bouleau jaune et frêne noir), le taux de dépérissement a été établi à 37 pour cent et pour les groupements les moins atteints, à un taux minimal de 12 pour cent.

Les données obtenues pour la croissance indiquent une diminution moyenne de 34,6 pour cent au cours des cinq dernières années.

L'analyse des sols indique une acidification des différents horizons ainsi que différentes carences au niveau des éléments

assimilables par les arbres, phénomène qui semble être apparu depuis quelques années.

Les causes communes de dépérissement, telles que les insectes, les maladies et les conditions climatiques, ne peuvent expliquer la situation actuelle bien qu'elles aient pu contribuer à en accélérer le processus. Même si l'on n'est pas encore parvenu à établir clairement les causes spécifiques, il apparaît aux chercheurs que les précipitations acides pourraient jouer un rôle très important dans ce phénomène du dépérissement en raison particulièrement du déséquilibre observé dans la fertilité des sols. D'ailleurs, la région la plus affectée reçoit des quantités de dépôts humides de sulfate de 36 kg/ha/an et le pH moyen des précipitations est de 4,3. Ces résultats préliminaires indiquent que nous devons demeurer vigilants et que des efforts de recherche sont nécessaires pour déterminer la relation entre les précipitations acides et le dommage aux forêts.

À la suite de plaintes formulées par les producteurs de sirop d'érable, l'Ontario a aussi initié une étude au cours de l'été 1984 sur le dépérissement des érablières observé au cours des dernières années et sa relation possible avec les précipitations acides.

À la suite de plaintes similaires, le Nouveau-Brunswick procèdera au cours de la prochaine année, à un relevé préliminaire sur la santé des peuplements d'érablières.

Près de 50 pour cent des forêts de l'Est du Canada sont situées dans les régions qui reçoivent des dépôts suffisants pour affecter les écosystèmes aquatiques. Les dommages potentiels aux forêts dus aux précipitations acides constituent une préoccupation plus grande que la préoccupation actuelle pour l'acidification des eaux de surface.

Effets sur la santé humaine

Le transport à grande distance des polluants atmosphériques peut menacer la santé et le bien-être des humains indirectement et directement bien que les recherches à ce sujet puissent être considérées insuffisantes à ce moment-ci. L'inhalation de niveaux élevés de substances respirables telles que les sulfates et autres particules fines et aérosols peuvent aussi produire des maladies respiratoires.

Dans une étude récente effectuée dans le sud de l'Ontario, un chercheur a décelé une corrélation positive entre le niveau de sulfate mesuré dans l'air ambiant et l'incidence relative de maladies respiratoires (morbidité).

Je crois que les résultats que je vous ai présentés sur les répercussions des précipitations acides sur le territoire canadien, situé à l'est de la frontière de la Saskatchewan et du Manitoba, permettent de mieux comprendre la position prise par les différents gouvernements provinciaux et fédéral en matière de précipitations acides.

Bien qu'il faille admettre que toute l'étendue de la portée et de l'ampleur des effets des précipitations acides de même que leur rythme d'évolution ne sont pas connus, il est évident cependant que notre compréhension des répercussions des précipitations acides sur l'environnement s'est améliorée grandement depuis le début de la décennie.

L'information acquise au cours de cette période permet une évaluation beaucoup plus précise des impacts des dépôts acides sur les ressources naturelles, qui non seulement représentent des valeurs inestimables et irremplaçables de la qualité de la vie et de notre héritage environnemental, mais constituent aussi le fondement des secteurs vitaux de l'économie de toutes les provinces.

Tout en reconnaissant qu'on doive maintenir les efforts de recherche impliquant des budgets de plus de 25 millions de dollars dans un avenir prévisible, de façon à évaluer et à définir plus précisément les répercussions des précipitations acides sur tout notre environnement et à acquérir une meilleure compréhension de certains aspects du problème, les résultats actuels continuent à réaffirmer notre croyance quant à l'urgence de ce problème et à la nécessité de développer et d'entreprendre des programmes de réduction des émissions.

D'autant plus que la majorité des effets constatés résulte des dépôts cumulatifs: l'étendue géographique et l'intensité des dommages augmenteront à moins qu'une action curative soit prise.

Origine de la pollution acide

Ceci m'amène à aborder l'origine de ce problème qui est le résultat de la transformation, du transport et du dépôt des polluants émis à l'atmosphère.

Puisque la majorité de l'acidité dans les dépôts humides est due aux acides sulfuriques et nitriques, les émissions de polluants précurseurs, qui méritent toute notre attention, sont l'anhydride sulfureux et les oxydes d'azote.

Les émissions totales des États-Unis en 1980 étaient de 24 millions de tonnes dont 19,0 provenaient de l'est des États-Unis; plus de 70 pour cent de ces émissions sont attribuables aux centrales thermiques.

Pour tout le Canada, les émissions permises étaient de 5,3 millions de tonnes dont 4,5 provenaient des provinces à l'est de la frontière Saskatchewan - Manitoba; 58 pour cent sont dues aux fonderies de métaux non ferreux.

Dans les deux pays, l'utilisation de combustibles fossiles pour des fins autres que la production d'électricité, constitue la seconde source d'émission en importance de SO_2.

Les émissions actuelles des oxydes d'azote aux États-Unis sont approximativement de 20 millions de tonnes dont 13,2 proviennent de l'est des États-Unis; près de 50 pour cent sont attribuables aux modes de transport et environ un tiers à la production d'électricité.

Au Canada, les modes de transport et la production d'électricité comptent respectivement pour 50 et 25 pour cent des émissions totales de 2,0 millions de tonnes dont 1,1 provient de l'est du Canada.

La répartition géographique des rejets aux États-Unis indique une forte concentration des rejets particulièrement dans les états du centre-ouest et au Canada; les rejets se concentrent notamment au Manitoba, en Ontario et au Québec.

Cette répartition est particulièrement importante lorsqu'on considère le transport à grande distance de ces polluants. En effet, les conditions météorologiques pour l'est de l'Amérique du Nord sont caractérisées par un vent prédominant d'ouest en est auquel est associé le transport des polluants à grande distance. On notera à cet égard que les provinces de l'Atlantique et les états de la Nouvelle-Angleterre sont particulièrement vulnérables à cette pollution transfrontalière, étant situés dans un corridor à l'est et sud-est des sources importantes du centre des États-Unis et du Canada. À l'inverse, ils n'exportent pas, sinon une part peu notable de leurs émissions.

Les dépôts annuels de dépôts de sulfate ont été calculés à l'aide de modèles de transport des polluants. Les niveaux observés de sulfate dans différentes régions s'accordent passablement bien avec les résultats obtenus par l'application de modèles à des régions importantes, sur une base annuelle.

Les contributions relatives de diverses sources de pollution aux dépôts de sulfate varient selon les zones réceptrices. Mais de façon générale, pour les zones les plus affectées du Québec et de l'Ontario, les sources canadiennes contribuent dans une proportion pratiquement égale à la contribution provenant des sources régionales américaines. Dans le cas des provinces de l'Atlantique, la contribution des sources régionales américaines excède celle des sources canadiennes.

Les dépôts acides dans différentes provinces indiquent une réduction d'environ 50 pour cent par rapport au niveau d'émissions de 1980 des sources des provinces de l'est et un effort comparable de la part des Américains est requis pour s'assurer que l'objectif environnemental de 20 kg/ha/an soit atteint dans toutes les régions affectées, notamment en Ontario et au Québec.

Programme de lutte contre les précipitations acides

Le contrôle de la pollution atmosphérique est d'abord une responsabilité des gouvernements provinciaux, tandis que le gouvernement fédéral est responsable des problèmes de pollution de nature internationale.

Aussi, considérant les responsabilités respectives des deux niveaux de gouvernement, il est évident que pour solutionner un problème tel que les précipitations acides, une approche coopérative s'imposait.

Dès le début de 1980 s'amorçait une telle coopération aux niveaux techniques et ministériels des huit gouvernements concernés et résultait en un certain nombre d'actions et de décisions importantes concernant la lutte aux précipitations acides.

Tout récemment, les gouvernements provinciaux et le fédéral ont convenu d'un programme de réduction des émissions et de la répartition des efforts d'assainissement entre les différentes provinces.

Voici les principaux accords et objectifs sur lesquels les Gouvernements se sont entendus.

Le 15 février 1982, les ministres de l'Environnement provinciaux et fédéral convenaient que dès 1990, les dépôts de sulfate humide devraient être réduits à un niveau inférieur à 20 kg/ha/an pour protéger les lacs et rivières modérément sensibles.

Pour obtenir un tel objectif, les Gouvernements ont alors reconnu que, pour le Canada, une réduction des émissions de l'ordre de 50 pour cent était requise des sources situées sur le territoire à l'est de la frontière Saskatchewan - Manitoba ainsi que sur tout le territoire américain à l'est du Mississipi.

À cette époque, un tel engagement des Gouvernements des provinces était conditionnel à la prise de mesures parallèles et compatibles de la part des États-Unis.

Cette proposition a été rejetée comme prématurée par le gouvernement fédéral américain et depuis, malgré les différentes initiatives et les échanges entre les deux gouvernements fédéraux, aucun rapprochement n'a été possible sur la nécessité d'entreprendre immédiatement un programme de réduction substantielle des émissions d'anhydride sulfureux.

Les discussions entre les provinces et le fédéral se sont poursuivies et le 6 mars 1984, les ministres de l'Environnement provinciaux et fédéral se sont mis d'accord pour procéder unilatéralement au développement et à la mise en oeuvre de mesures additionnelles de réduction de l'anhydride sulfureux. Ces mesures ont pour but de réduire de 50 pour cent les émissions d'anhydride sulfureux à l'est de la frontière de la Saskatchewan et du Manitoba par rapport aux émissions permises de 1980.

Cette entente a été possible parce que les ministres concernés reconnaissent qu'il ne serait pas prudent, compte tenu des dommages persistants à l'environnement et à nos ressources, de retarder la mise en place de programme d'assainissement en attendant un changement de la position fédérale américaine.

Des démarches ont par la suite été entreprises afin d'établir les détails du programme de réduction prévoyant une diminution des émissions de 2,3 millions, incluant la répartition des efforts d'assainissement entre les provinces et l'échéancier de sa mise en place.

C'est le 5 février de cette année que les ministres de l'Environnement du Manitoba, de l'Ontario, du Québec, du Nouveau-Brunswick, de la Nouvelle-Écosse et de Terre-Neuve et le ministre fédéral de l'Environnement concluaient une entente comportant la répartition des efforts d'assainissement à réaliser d'ici 1994.

Voici les principaux engagements pris par chacune des provinces lors de cette entente du 5 février dernier.

Au Manitoba, les émissions permises en 1980 étaient de 738 000 tonnes, dont 96 pour cent provenaient de deux fonderies de métaux non ferreux. Cette province acceptait de réduire de 188 000 tonnes les émissions provenant de ce secteur et cette réduction sera possiblement obtenue par l'application de technologie nouvelle.

Pour l'Ontario, responsable de près de 50 pour cent des émissions de l'est du Canada tout en étant une zone des plus touchées par les émissions américaines, les émissions permises en 1980 s'élevaient à 2 194 000 tonnes. Les secteurs responsables de ces émissions étaient principalement les fonderies de métaux non ferreux (50 pour cent), suivies des centrales thermiques (20 pour cent).

Cette province s'est engagée à réduire ses émissions de 1 164 000 tonnes (53 pour cent) d'ici 1994. Déjà, en 1980, cette province avait adopté des règlements visant les secteurs précités prévoyant des réductions de 426 000 tonnes pour les fonderies de métaux non ferreux dès 1983, et de 192 000 tonnes pour les centrales thermiques dès 1990, pour une réduction totale de 618 000 tonnes, soit de 28 pour cent, les émissions résiduaires s'élevant à 1 500 000 tonnes. Dans le cas des fonderies, ces réductions d'émissions seront probablement rattachées à un programme de modernisation pendant que l'entrée en service de nouvelles centrales nucléaires aidera sans doute à réduire les rejets des centrales thermiques.

Au Québec, les émissions réelles en 1980 totalisaient 1 085 000 dont plus de 59 pour cent dues aux fonderies de cuivre et 24 pour cent à l'utilisation des combustibles fossiles.

Le Québec s'est engagé à réduire ces rejets de 485 000 tonnes, soit de 45 pour cent d'ici 1990. D'ailleurs, dès 1981, le Québec amorçait un programme visant à réduire de 200 000 tonnes (près de 20 pour cent) ses rejets d'anhydride sulfureux d'ici la fin de 1984. Ces réductions ont été obtenues par l'amélioration de la fixation du SO_2 à une des fonderies de cuivre, le programme de modernisation et d'assainissement des fabriques de pâtes et papiers, et plus particulièrement par les changements survenus dans l'utilisation de combustibles à la suite de nouvelles mesures de conservation d'énergie, la substitution de l'huile lourde par le gaz naturel et l'électricité et des nouvelles normes sur la teneur en soufre des combustibles.

En février dernier, le Québec adoptait une importante réglementation devant permettre d'atteindre l'objectif d'assainissement de 45 pour cent auquel il s'était engagé. Les réductions additionnelles de plus de 285 000 tonnes seront obtenues en grande partie par une diminution de 50 pour cent des émissions de la fonderie de cuivre Horne de Mine Noranda, de loin la plus importante source de SO_2 du Québec, et

qui nécessitera la mise en place d'une usine d'acide sulfurique; et à un degré moindre, par une réduction additionnelle des émissions des fabriques de pâtes et papiers. Cette réglementation porte aussi sur le contrôle des émissions d'oxydes d'azote provenant des véhicules automobiles.

Le Nouveau-Brunswick s'est engagé pour sa part à réduire ses émissions de 30 000 tonnes par rapport à ses émissions réelles de 215 000 tonnes en 1980. Une telle réduction a déjà été obtenue à la fin de 1984 à la suite de la diminution de l'utilisation de l'huile et du programme d'assainissement des fabriques de pâtes et papiers, qui ont plus que compensé les émissions additionnelles découlant d'une augmentation de la consommation du charbon. Cette province développe actuellement une politique permettant de maintenir le niveau actuel des émissions au-delà de 1994. Les options principales considérées sont le lavage du charbon, l'addition de génération d'électricité hydraulique et nucléaire et l'importation d'électricité.

La Nouvelle-Écosse contribuait pour sa part à 219 000 tonnes d'anhydride sulfureux en 1980, dont 47 pour cent étaient associées à la production d'électricité et 12 pour cent à l'utilisation des combustibles fossiles. Cette province s'est engagée à réduire de 15 000 tonnes ses émissions actuelles et ce, malgré l'augmentation anticipée de production d'électricité thermique. Les mesures envisagées comprennent l'utilisation d'un charbon à plus faible teneur en soufre et le lavage du charbon.

En 1980, les émissions de Terre-Neuve s'élevaient à 59 000 tonnes, dont plus de 50 pour cent provenaient de l'utilisation de combustible à des fins autres que la production d'électricité et un tiers d'une centrale thermique. Terre-Neuve s'est engagé à réduire de 14 000 tonnes ses rejets actuels et entend maintenir plusieurs programmes visant à réduire l'utilisation de l'huile en la substituant par d'autres sources d'énergie. La mise en marche d'une nouvelle

centrale hydro-électrique réduira l'utilisation de la seule centrale thermique de l'Île.

Finalement, l'Île-du-Prince-Édouard, avec une émission de 6000 tonnes, prévoit diminuer quelque peu ses rejets même s'ils sont très négligeables.

On doit poursuivre davantage les efforts de réduction afin de rencontrer l'objectif qui est d'obtenir des émissions n'excédant pas 2,3 millions de tonnes pour l'est du Canada. Présentement il reste à partager une réduction de 400 000 tonnes entre les provinces. Il est important de noter que toute émission nouvelle, indépendamment de son niveau d'assainissement, devra être compensée.

La réalisation de ce programme d'assainissement sera dispendieux. Les coûts varient, dépendant comment et où les réductions doivent être obtenues. Les coûts annuels des mesures nécessaires sont estimés à entre 600 millions et un milliard de dollars par année. Des capitaux de 1,1 à 1,5 milliard seront requis dans l'industrie des métaux non ferreux. Des dépenses en capital d'un milliard pourraient être requises dans le domaine de la production d'électricité. Ceci dépend d'un certain nombre de facteurs incluant la disponibilité de puissance nucléaire.

Il faut souligner aussi que le 6 mars dernier, le gouvernement fédéral annonçait de nouvelles mesures en vue de lutter contre les précipitations acides.

En effet, pour appuyer le programme d'assainissement d'anhydride sulfureux, le Gouvernement s'engageait dans un programme de subvention et de nouvelles mesures législatives applicables aux véhicules automobiles, prévoyant entre autres le resserrement des normes d'émission des oxydes d'azote et ce, à partir de septembre 1987. Ces nouvelles normes sont aussi strictes que celles en vigueur aux États-

Unis et devraient résulter au cours des années en une réduction de 45 pour cent des oxydes d'azote.

La réalisation des différents éléments des programmes provinciaux et du gouvernement fédéral apportera des bénéfices tangibles à l'environnement.

Il semble que la majorité des régions des provinces de l'Atlantique continueront à recevoir des dépôts inférieurs à 20 kg/ha/an, ce qui permettra à l'environnement dans ces régions d'amorcer le long processus de la restauration et d'être sauvegardé dans un avenir prévisible.

Il est toutefois évident que d'importantes zones du Québec et de l'Ontario continueront à recevoir des dépôts acides bien supérieurs au seuil de 20 kg/ha/an, étant influencées de façon plus significative par les sources américaines. Néanmoins, même dans ces cas, il se produira certaines améliorations.

On peut certes dire aujourd'hui que la lutte contre les précipitations acides dans tout l'est du Canada, a fait un pas significatif grâce aux Gouvernements qui ensemble ont travaillé pour promouvoir un programme d'assainissement qui devrait nous approcher de l'objectif de dépôt de 20 kg/ha/an.

Toutefois, une ombre demeure à ce tableau. Notre problème de précipitations acides est causé non seulement par une multitude de sources d'émission dans les provinces canadiennes mais aussi des États-Unis et par conséquent, ce problème a des implications inter-jurisdictionnelles évidentes et ne saurait être solutionné sans une contribution essentielle des Etats-Unis.

Cette situation de dépendance réciproque a incité plusieurs provinces à collaborer étroitement non seulement entre elles, mais aussi avec les Gouvernements des états voisins des États-Unis et à apporter leur appui entier au gouvernement fédéral canadien dans ses discussions avec le gouvernement fédéral américain en vue de signer une entente internationale pour combattre les précipitations acides conformément au Mémoire déclaratif d'intention Canada - États-Unis de 1980.

C'est ainsi que le Québec et les provinces de l'Atlantique sont partis à une concertation multilatérale avec les États de la Nouvelle-Angleterre sur ce problème, et ce, depuis 1981.

Il est important de souligner qu'en juin dernier, lors de la 12e Conférence annuelle, une des résolutions adoptées par les six gouvernements de la Nouvelle-Angleterre et les cinq premiers ministres des provinces de l'Atlantique et du Québec établissaient un Comité ad hoc sur l'environnement, avec comme mandat prioritaire, le développement d'un plan d'action régional à court terme de réduction des émissions d'anhydride sulfureux pour les États et provinces membres de la Conférence.

C'est aussi grâce à l'initiative de ces mêmes Gouvernements que nous sommes réunis ici pour échanger sur cette question. Nous sommes convaincus que des liens développés entre les différents participants contribueront à établir et à maintenir un dialogue entre l'ensemble des États et provinces représentés à cette conférence.

Certaines provinces, notamment le Québec et l'Ontario, ont aussi élargi leurs relations avec les Gouvernements voisins, en particulier avec les États qui partagent leurs frontières et avec lesquels, à cause de leur proximité, elles ont toujours entretenu des relations étroites.

Chacune de ces provinces a signé un accord bilatéral avec New York. Pour le Québec et New York, la première entente à survenir entre un État et une province dans ce domaine (1982) a résulté en des échanges d'information scientifique, à l'initiative d'une étude mixte, et à l'établissement d'un centre de documentation et de la diffusion d'une banque bibliographique informatisée sur les précipitations acides, qui a été rendue publique au cours de cette conférence.

De plus, comme les préoccupations de ces deux Gouvernements augmentaient, des engagements ont été pris par le Québec et l'État de New York qui se sont traduits par l'annonce de leur programme respectif d'assainissement d'anhydride sulfureux au cours de l'été 1984.

Je dois vous dire, en guise de conclusion, que les provinces de l'Est du Canada sont très fières du chemin parcouru depuis 1980 pour trouver des solutions au problème des précipitations acides. Elles ont accompli ce cheminement, en étroite collaboration avec le gouvernement fédéral de ce pays.

C'est par des discussions, par des échanges, à l'occasion d'événements comme cette conférence, que nous avons tous pris conscience de l'importance du problème des précipitations acides et de la nécessité de poser des gestes concrets visant à réduire à la source les contaminants précurseurs des précipitations acides provenant des territoires relevant de notre compétence.

Nous n'avons pas trouvé de solution-miracle pour régler ce problème, mais nous avons mis au point un processus fondé sur le dialogue et la concertation qui nous a permis de développer un remarquable consensus social sur la nécessité d'agir pour solutionner ce problème et d'engager, dans cette action, tous les partenaires sociaux, économiques et gouvernementaux. C'est ainsi que nous avons franchi les étapes, une à une, et que nous avons pris les engagements très clairs qui, nous en somme convaincus, nous mettent sur la voie d'un

redressement environnemental; cependant, il ne pourra être atteint complètement sans la collaboration des autres Gouvernements de ce continent.

Déjà, nos engagements ont donné des résultats au chapitre de l'assainissement des émissions d'anhydride sulfureux. Des centaines de milliers de tonnes métriques d'anhydride sulfureux ont déjà été assainies depuis le début de nos discussions et de nos efforts d'assainissement. Nous avons également adopté certaines mesures réglementaires et amorcé un programme de financement.

Nous sommes anxieux de poursuivre ce cheminement avec d'autres partenaires dans le but d'assumer pleinement nos responsabilités de gestionnaires, de gardiens et de protecteurs de l'environnement commun que nous partageons sur ce continent.

BIBLIOGRAPHIE

M. Jean Piette est directeur des stratégies et politiques environnementales du ministère de l'Environnement du Québec. À ce titre, il coordonne la préparation des normes environnementales réglementaires, assure la préparation d'études et d'analyses économiques relatives aux programmes, élabore les politiques et orientations du Ministère dans ses principaux secteurs d'intervention et coordonne la mise en oeuvre de la politique québécoise en matière de précipitations acides. Il a participé à de nombreux colloques et conférences portant sur les précipitations acides au Canada comme aux États-Unis. M. Piette fut directeur des Services juridiques du ministère de l'Environnement du Québec (1980 à 1983). Il est diplômé de l'Université de Montréal (Licence en droit) et de l'université Georges-Washington (MCL).

CONCLUSIONS/CONCLUSIONS AND CLOSING REMARKS

Adrien Ouellette
Ministre de l'Environnement du Québec

James Hoyte
Secretary of Environmental Affairs
Massachusetts

ALLOCUTION
DE MONSIEUR ADRIEN OUELLETTE
Ministre de l'Environnement du Québec

Je voudrais vous exprimer la très grande satisfaction du gouvernement du Québec à la suite de la tenue de cette conférence qui, je le pense, prendra d'ici peu un caractère historique. Il existe de bonnes raisons pour que le gouvernement du Québec soit à ce point heureux des résultats de cette conférence.

Il y a d'abord, bien sûr, vous l'avez tous remarqué, le nombre élevé de participants. Ce n'est pas tous les jours qu'il nous est possible de réunir sous un même toit des représentants de 22 Gouvernements d'états et de provinces d'Amérique du Nord sur un sujet aussi important que celui des précipitations acides.

Il faut également souligner la qualité des intervenants. La conférence réunit 22 Gouvernements, douze ministres responsables de l'environnement, quatre Gouverneurs d'états américains et un Premier ministre d'une province canadienne.

Il y a également la participation du milieu scientifique. Nous avons eu l'occasion d'entendre des exposés remarquables faits par des femmes et des hommes de science compétents venus nous livrer le contenu de leurs recherches et de leurs observations. Ce faisant, ils nous ont également sensibilisés davantage aux risques que nous courons si nous n'agissons pas très rapidement. L'intérêt manifesté, de même que le sérieux exprimé par tous ces participants sont de nature à nous rendre très fiers des résultats de cette conférence.

Nous avons entendu plusieurs exposés et remarques qui nous ont confirmé dans certains cas, ou qui nous ont appris dans d'autres, l'importance et la sagesse d'agir sans attendre pour lutter contre les précipitations acides.

Je crois que nous admettrons unanimement, comme les scientifiques et les hommes politiques l'ont très bien exposé au cours de cette conférence, qu'il y a un lien évident entre les dommages que nous observons sur nos territoires respectifs et les précipitations acides en général. Il nous apparaît donc sage d'accélérer nos actions respectives et collectives pour précipiter la solution de ce problème. Je m'excuse presque d'utiliser le verbe précipiter puisque nous l'utilisons avec les précipitations acides. Mais, si nous avons des précipitations acides, il faudrait peut-être, dans les plus brefs délais, précipiter notre action pour éliminer ces autres précipitations.

Pourquoi est-il si urgent d'agir? Il nous semble évident aussi, à la suite de ce que nous avons appris ici et ce que nous connaissons déjà en partie, qu'il faut le faire dans les plus brefs délais car nous y voyons là un motif économique. Plus nous attendrons, plus les coûts des solutions seront élevés, plus les dégâts que nous devrons réparer généreront des coûts importants. Il est donc urgent d'agir puisque nous possédons déjà des connaissances suffisantes du degré de gravité et une bonne partie de la technologie nécessaire au règlement de ce problème.

Je me réfère à l'exposé du Gouverneur Earl qui nous décrivait la situation qui prévaut en Europe, notamment dans la Forêt Noire, et à d'autres exposés qui nous ont également été présentés. Il y a dix ans, bien sûr, il aurait été impossible de persuader la majorité du peuple allemand d'intervenir et d'investir des sommes d'argent dans la solution puisque rien n'était pour eux tellement apparent. Mais, au cours des dernières années, les Allemands et les Européens en général ont été témoins d'un dépérissement progressif de leur environnement et de leurs forêts et, c'est à ce moment qu'ils ont véritablement ouvert les yeux et senti la très grande gravité du problème.

Il en est de même pour la région québécoise que je représente au gouvernement du Québec, la Beauce, pays de l'érable où l'on retrouve de très grandes érablières. Il m'aurait été difficile, en 1976, de faire une campagne électorale dans ma région et d'essayer de me faire élire par les producteurs d'érables sur le thème du dépérissement de leurs érablières. Mais déjà, depuis deux, trois ou quatre ans, les dommages sont devenus tellement visibles qu'il me sera peut-être possible, aux prochaines élections, d'utiliser ce thème et de leur dire que le gouvernement du Québec entend prendre les moyens et qu'il a déjà d'ailleurs pris une bonne partie de ces moyens pour faire en sorte que ce dépérissement cesse.

En d'autres termes, il devient plus facile de faire avancer une cause lorsque les effets négatifs deviennent de plus en plus visibles.

Nous avons également été témoins, lors de cette conférence, de l'existence de plus en plus évidente d'une volonté politique d'agir. Tout au long de l'avant-midi, nous avons entendu quatre intervenants nous exposer les actions et les politiques prises par les différents gouvernements des régions qu'ils représentent.

Nous avons vu qu'au Canada, à la suite de nombreux pourparlers et de nombreuses discussions qui ont pris naissance, jusqu'à un certain point, au Québec, mais qui se sont étendus à l'ensemble des sept provinces de l'Est du Canada, que nous étions de plus en plus conscients et de plus en plus désireux de passer aux actions concrètes pour résoudre le problème des précipitations acides.

Nous avons eu aussi droit à des exposés des représentants du territoire américain qui nous ont également démontré cette volonté politique.

Bien sûr, nous avons également pris connaissance de certaines divergences d'opinions. Nous ne pouvons dire que tous étaient unanimes sur chacun des détails qui ont été exposés ici au cours de ces deux jours. Il existe des divergences, mais je pense, c'est du moins l'évaluation que je fais personnellement, qu'elles résultent du fait que la situation diffère dans chacune des provinces ou dans chacun des états. La solution aux précipitations acides qui doit être appliquée au Québec n'est pas nécessairement celle qui peut être appliquée par exemple dans l'état de l'Ohio ou même en Ontario. Et c'est peut-être en raison de ces réalités différentes que nous retrouvons certaines divergences d'interprétation dans l'identification des moyens et des volontés politiques.

À mon avis, seule la poursuite du dialogue nous amènera, non seulement à établir un consensus réellement fort entre nous tous, que nous soyons Américains ou Canadiens, mais il faudra qu'il se fasse par le dialogue et par les échanges d'informations. Et c'était là, je crois, un des objectifs premiers de cette conférence.

Mais nous devons envisager que ce dialogue qui entraînera le consensus entre nous fera également tache d'huile pour faire en sorte que, dans les plus brefs délais, tous les Gouvernements nord-américains en viennent à établir une politique globale de lutte contre les précipitations acides pour que nous nous débarrassions à tout jamais de ce fléau qui risque de déboucher sur des conséquences économiques terribles.

Je pense aussi qu'il a été établi, lors de cette conférence, que le 20 kilogrammes/hectare/année, qui a fait l'objet d'un consensus en terme de seuil pour les milieux modérément sensibles, sera appelé à être abaissé au fur et à mesure que nous passerons à l'action. C'est bien sûr que la norme de 20 kilogrammes/hectare/année peut convenir à certaines de nos régions modérément sensibles, mais nous avons tous, sur chacun de nos territoires, des régions plus sensibles. Ce qui signifie

que nous devrons tendre, même le jour où nous aurons atteint ce 20 kilogrammes, à l'abaisser de façon à protéger parfaitement notre territoire.

Je pense que nous devons tous agir chez nous, sur notre territoire, ayant à l'esprit, et c'est peut-être un changement pour certains, que notre action chez nous n'est pas que bénéfique pour le voisin situé au nord-est. Si le Québec diminue ses émissions, bien sûr que les provinces de l'Atlantique en profiteront, mais le Québec aussi en profitera, puisqu'il est lui-même victime de ses propres émissions. Ce raisonnement peut s'appliquer à chacun de nos territoires.

Monsieur Piette faisait allusion à une étude que nous avons menée dans la région du Nord-Ouest québécois dans une zone située près de l'usine de Noranda qui est un très grand pollueur, et cette étude nous révèle que les premières victimes des émissions de Noranda sont, d'abord et avant tout, les personnes qui vivent dans son environnement immédiat. C'est donc dire que notre action ne se fait pas qu'au profit des autres, mais que nous sommes les premiers à en profiter.

Je vous répète en terminant que le succès de cette conférence est dû, bien sûr, au grand nombre de participants, à l'intérêt qu'ils ont manifesté, au calibre élevé des personnes qui sont venues nous entretenir sur différents sujets. Mais ce succès est également directement relié à la qualité des gens qui l'ont préparée. Et je fais ici une allusion directe aux fonctionnaires de ces 22 États participants. J'ai vu travailler les fonctionnaires du Québec et particulièrement ceux des ministères de l'Environnement, voire même du ministère de l'Énergie et des Ressources et je suis certain que cette ardeur au travail s'est manifestée chez tous les fonctionnaires de chacun des 22 États participants. Je dois donc les remercier avec beaucoup de sincérité au nom du gouvernement du Québec.

Je veux aussi remercier, de façon particulière, les responsables de la traduction simultanée. Je le fais avec un malin plaisir puisque j'ai été à la fois leur principal client et leur principal fournisseur. Et soyez reconnaissants à leur endroit car, si j'avais dû m'exprimer en anglais, cela aurait été plus long et sûrement beaucoup plus pénible pour vous. Je remercie aussi le personnel technique qui a vu à l'organisation de cette conférence.

Comme l'évoquait monsieur Lévesque, selon un vieux proverbe chinois, je termine avec le voeu que cette conférence constitue la moitié de notre chemin, c'est-à-dire le premier pas, et qu'elle ait des suites tangibles. Il y a d'autres étapes à franchir et c'est par un dialogue comme celui qui s'est engagé, que nous y parviendrons. C'est du moins la stratégie que nous avons utilisée au Canada et je pense que les résultats auxquels nous sommes parvenus depuis les trois dernières années démontrent qu'elle vaut vraiment la peine d'être reprise hors de la frontière canadienne et des états de Nouvelle-Angleterre, afin d'aller chercher un maximum d'États américains pour que cette prise de conscience se fasse au profit de la collectivité nord-américaine.

BIOGRAPHIE

Monsieur Adrien Ouellette fut ministre de l'Environnement du Québec de septembre 1982 à décembre 1985. Il était auparavant l'adjoint parlementaire du ministre des Transports (1981) et du ministre de l'Industrie, du Commerce et du Tourisme (1979).

Monsieur Ouellette est un enseignant de carrière. Très engagé dans son milieu, il a également assumé plusieurs tâches au sein d'organismes sociaux et municipaux. Il a d'ailleurs été maire de la ville de Saint-Joseph-de-Beauce de 1968 à 1976.

REMARKS

Mr. James Hoyte

Secretary of Environmental Affairs

Massachusetts

Thank you very much, Minister Ouellette. Before commenting generally about the conference and where we go from here, let me just say that I thank you personnally. I know Governor Dukakis joins with me in that for your wonderful hospitality, the hospitality of the Government of Québec and all those who were involved in the development of this conference and in hosting us here. It will be pretty tough to follow. I have talked to my colleagues from New England and we all wonder just how we will meet the measure that you have established if we are involved in further conferences of this nature.

With that I might just say, given your very, very fine summary, that I do not think that there are any particular points that I want to underline, except under the general heading of where do we go from here. It seems to me that you have identified the existence of strong political will exhibited here. It seems moreover, that one of the things that all of us clearly will be doing hereof is going back with a mandate for action and continuing on with the programs that were outlined. Beyond that however it is important that we bring to the premiers and the governors at the conference in June the notion that this was quite a successful effort, one that ought in fact to be followed up again next year with a similar focused sharing of information and commitment, and hopefully a report on further progress. It seems to me that that ought to occur in one of the New England states and I hope that that will be one of the agenda items for our premiers and governors in June.

In addition, I would hope that we can begin to move together towards some sort of program for identifying appropriate measurements for progress towards our mutual goals. There has been some discussion amongst various participants of that need. Again, it seems to me an agenda item, that might be brought to the premiers and the governors in June, would be the appropriateness of trying to identify a measurement process that we could all look to so that we know where we are going and where we have been.

Finally, it has been noted by several people, but I think it is worth noting again, that at that June meeting we do have a mandate to bring back a recommendation for a plan, a short-term plan for emission reductions. We have that mandate that was outlined at the last meeting of the premiers and New England governors and it is our full expectation through the Committee on Environment to present such a plan in June.

Hence, what we can all agree upon is that the conference has in fact been a step, a step in the direction of a mutual goal towards solving this very difficult problem. In that regard it was a strong success and I congratulate all of you and all the participants.

BIOGRAPHY

Environmental Affairs Secretary James S. Hoyte is a graduate of Harvard College and Harvard Law School.

Upon graduation from Law School, Mr. Hoyte worked briefly for the General Foods Corporation and then as a Management Consultant for Arthur D. Little, Incorporated.

After nearly six years with Arthur D. Little, Mr Hoyte ventured into public service as Deputy Secretary for Commercial Affairs and Director of Corporations for the Secretary of State's Office. From there, Mr. Hoyte moved on to the Massachusetts Port Authority where he served as Secretary Treasurer and Director of Administration for three years.

In early 1979, Mr. Hoyte returned to Arthur D. Little as Vice President of their Program systems Management Company. In January of 1983, Mr. Hoyte returned to public service as Secretary of Environmental Affairs for the Dukakis Administration.

COMMUNIQUÉ FINAL DE LA CONFÉRENCE

Le ministre de l'Environnement du Québec, monsieur Adrien Ouellette et le Secretary of Environmental Affairs du Massachusetts, monsieur James Hoyte ont livré les conclusions de la Conférence intergouvernementale sur les précipitations acides qui a réuni les représentants de vingt-deux états et provinces à Québec.

Cette conférence a permis de constater les liens étroits entre les précipitations acides et le dépérissement significatif des forêts, élément nouveau de la problématique de l'est du continent américain. Pour leur part, les effets des précipitations acides sur les écosystèmes aquatiques étaient déjà bien documentés.

Ils ont constaté que les informations sur les effets des précipitations acides sont suffisantes pour justifier dès maintenant la mise en oeuvre de programmes de réduction substantielle des émissions des principaux polluants précurseurs, notamment l'anhydride sulfureux (SO_2) et les oxydes d'azote (NO_x). Des recherches supplémentaires sont nécessaires pour mieux comprendre certains aspects des problèmes. On peut s'attendre par ailleurs à ce que ces recherches conduisent à des programmes de contrôle de plus grande envergure. À titre d'exemple, on a récemment mis en évidence le rôle de l'ozone et des oxydes d'azote (NO_x) sur les forêts de certaines régions.

Monsieur Ouellette et monsieur Hoyte ont aussi insisté sur la nécessité d'une action immédiate et ils ont souligné à cet égard qu'il est sans doute plus économique d'agir maintenant. Incidemment, l'évolution rapide du dépérissement des forêts nous porte à croire qu'il est déjà tard lorsque les signes visibles de dépérissement apparaissent.

Ils ont constaté avec satisfaction qu'il existe une volonté politique d'agir. Des progrès ont déjà été réalisés; mais il faut aller

plus loin. Les provinces de l'Est du Canada se sont déjà engagées dans un programme substantiel de réduction et certains États américains, tels les États de New York, du New Hampshire, du Maine et du Massachusetts ont pris ou s'apprêtent à prendre de nouvelles mesures législatives. Il est cependant nécessaire que cette volonté politique se développe et soit appuyée par une plus grande sensibilisation de la population, comme le fera la Semaine internationale sur les précipitations acides qui se tiendra la semaine prochaine, et comme l'a fait la Conférence de cette semaine.

Ils ont constaté également que des interventions progressives doivent être envisagées. Dans un premier temps, il est important d'atteindre l'objectif de 20 kg/hectare/année de dépôt humide de sulfate dans les meilleurs délais. Ultérieurement, et en tenant compte des résultats des recherches scientifiques, il faudra peut être envisager d'abaisser cet objectif pour protéger les écosystèmes les plus sensibles.

Enfin, ils ont insisté sur le fait que les actions prises par chacun des gouvernements ne sont pas seulement bénéfiques pour les états voisins mais également pour leurs propres territoires, pour la santé de leur population et la qualité de leurs forêts et de leurs lacs.

Monsieur Ouellette et monsieur Hoyte se sont donc dits très satisfaits du succès de cette importance conférence intergouvernementale et ont affirmé que les objectifs visés ont été atteints.

Ils ont rappelé que cette conférence visait, entre autres, à rapprocher des États et des provinces dont les préoccupations sont différentes.

Monsieu- Ouellette et monsieur Hoyte ont conclu en disant que le nombre de participants à cette conférence et leur haut niveau de responsabilité démontrent la pertinence et l'intérêt d'échanges plus soutenus sur ce problème majeur d'intérêt commun.

FINAL STATEMENT OF THE CONFERENCE

The Environment Minister of Québec, Monsieur Adrien Ouellette and the Secretary of Environmental Affairs of Massachusetts, Mr. James Hoyte, have concluded the Intergovernmental Conference on Acid Rain. Representatives of twenty-two States and provinces attended the two day conference in Québec City.

Scientific information pointed at this conference indicated some links between acid rain and related air pollutants and damages to forests which are an emerging concern in North America. The effects of acid rain on aquatic ecosystems have already been well documented.

They have concluded that information available to decision makers on the effects of acid rain is sufficient to justify implementing substantial sulphur dioxide and nitrogen oxide emission reduction programs now. Additional research is necessary to understand specific aspects of this problem. Additional research is likely to induce more comprehensive reduction programs aimed at air pollution control. For example, the role of ozone and oxides of nitrogen on forests in certain regions is being analyzed.

Mr. Ouellette and Secretary Hoyte are in agreement that immediate action is necessary. They have underlined the fact that it is more cost effective to act now rather than delay. For example, the visible signs of forest die-back may indicate that we are very late in our reaction.

They noted that there is a political will for action. Some progress was achieved but further action is needed. Eastern Canadian provinces have already agreed to a substantial control program and some American States such as New York, New Hampshire, Maine and Massachusetts have adopted or considered introducing legislative measures.

However, it is necessary that this political will be developed and supported by a greater public awareness. This will be facilitated by the upcoming International Week on Acid Rain and has been evidenced by this week's conference.

They also noted that additional action must be taken. As a first step, it is important to achieve the 20 kg/ha/yr of wet sulphate deposition as soon as possible. Later, and in keeping with all scientific research results, it is likely that this target shall be lowered to protect sufficiently the more sensitive ecosystems.

Finally, they insisted on the fact that actions taken by each of them are not only beneficial for neighbor States but also for their own territories, for the health of their population as well as the quality of their forests and lakes.

Consequently, Mr. Ouellette and Mr. Hoyte indicated their satisfaction with the success of this important intergovernmental conference and stated that the goals of the conference were achieved.

They reminded participants that, among others, of this conference was to bring closer the States and provinces that have different points of view.

Mr. Ouellette and Mr. Hoyte concluded by stating that the number of participants to this conference and their high level of responsibility demonstrate the pertinence and interest of more sustained exchanges with respect to this major and common problem.

CONFÉRENCE DE PRESSE/PRESS CONFERENCE

12 AVRIL 1985
APRIL 12, 1985

PARTICIPANTS/PARTICIPANTS

Adrien Ouellette
Ministre de l'Environnement du Québec

James Hoyte
Secretary of Environmental Affairs
Massachusetts

ADRIEN OUELLETTE: Bonjour! J'ai eu l'occasion à la fin de cette conférence intergouvernementale sur les précipitations acides d'exprimer la très grande satisfaction du gouvernement du Québec. Notre satisfaction vient d'abord du fait que quinze Gouvernements d'états américains et sept Gouvernements de provinces canadiennes y étaient représentés. Il y a également le fait que quatre Gouverneurs américains faisaient partie des différentes délégations et que le Premier ministre du Québec a accepté de co-présider cette conférence avec le Gouverneur Dukakis.

Notre satisfaction est également reliée au fait que nous avons pu mettre en commun et partager un certain nombre de connaissances et d'informations nouvelles. Cette conférence nous a de plus permis de prendre connaissance des perceptions des différents Gouvernements sur l'importance du problème des précipitations acides.

Il a été établi très clairement qu'il ne serait pas sage d'attendre pour intervenir massivement dans le domaine des précipitations acides puisque les conséquences écologiques et économiques seraient presque catastrophiques, surtout lorsque nous regardons ce qui se passe en Europe où on a, semble-t-il, attendu trop longtemps avant d'intervenir.

Nous avons pu entendre des conférenciers de très haut calibre, des hommes et des femmes du milieu scientifique, qui nous ont clairement exposé la situation qui prévaut, non seulement en Europe, mais aussi sur le territoire de chacun de nos États respectifs.

Et, bien sûr, nous avons conclu en soulignant le fait que cette conférence devrait avoir des suites si nous voulons faire avancer la cause que nous soutenons tous c'est-à-dire la lutte contre les précipitations acides. Et nous avons convenu très clairement que seul le

dialogue peut engendrer le consensus et qu'une fois établi entre nous, ce consensus prendra plus d'importance dans la mesure où nous réussirons à y inclure progressivement d'autres États.

J'ai à mes côtés le ministre de l'Environnement du Massachusetts, monsieur Hoyte, qui aurait peut-être quelques mots à ajouter.

JAMES HOYTE: Let me just emphasize that we feel very strongly that the conference has indeed been a success. It has provided us with a common basis for information and a basis to move forward with a continued exchange that, really, I would just echo what the Minister indicated, and only with such a common basis can we move towards consensus.

At the same time, I think it is very important to recognize the statements and indications of political will that were demonstrated at this conference and the fact that there are individual efforts that a number of states and provinces are pursuing, and will continue to pursue. But we all recognize that only as we develop a national program and indeed a multinational program can we achieve the overall goal. That is really the general statement that I would have and I would be glad to answer any questions.

UN JOURNALISTE: Monsieur Adrien Ouellette, monsieur Hoyte, comment interprétez-vous le fait que les émissaires, qui ont été nommés par monsieur Reagan et monsieur Mulroney aient été invités et n'aient pas assisté à la conférence, alors qu'il s'agissait, je crois, d'une occasion en or de connaître ce qui se passe vraiment dans le secteur?

MONSIEUR ADRIEN OUELLETTE: Effectivement, nous avions invité ces deux envoyés spéciaux, ces deux personnes désignées par le Canada et les États-Unis, mais ils ont préféré ne pas venir, préférant, j'imagine, se rencontrer préalablement avant de faire une première apparition publique.

Je vous rappellerai que ce sont deux politiciens de grande expérience et qu'ils ont fait preuve de prudence. Avant de se présenter en public, je crois qu'ils ont besoin de s'entendre, d'établir une stratégie et nul doute qu'un rapport leur sera fait de cette conférence qui servira à alimenter leurs réflexions.

UN JOURNALISTE: D'autre part, il y a monsieur Sununu qui a été fort critique de ce que le Canada n'a pas fait et, même s'il le faisait, semble-t-il qu'on arriverait seulement à la cheville de ce que les Américains font. Comment interprétez-vous ce qui s'est dit de la part du New Hampshire?

MONSIEUR ADRIEN OUELLETTE: En fait, monsieur Sununu appuie sa théorie sur une façon de calculer les émissions de SO_2 tant aux États-Unis qu'au Canada. C'est une façon que nous ne partageons pas au Québec, ce n'est pas du tout notre façon de voir.

Et il nous sera donné, bien sûr, de poursuivre les discussions avec monsieur Sununu et ses adjoints administratifs pour clarifier cette situation.

Nous disons que l'objectif poursuivi par le Canada, et qui a fait l'objet d'un consensus des sept provinces canadiennes, est de ramener à 20 kilogrammes/hectares/année les dépôts humides de sulfate. Et, si nous voulons atteindre ce seuil qui devra possiblement être abaissé, si on se réfère à ce qui nous a été dit au cours des deux derniers jours, la seule façon d'y arriver est de réduire les émissions là où elles se trouvent.

Il faudra donc porter notre action là où sont les causes de pollution. Et cette façon de voir ne rejoint pas tellement celle de monsieur Sununu. Nous devrons avoir d'autres discussions avec ce gouverneur pour l'amener à faire équipe dans la lutte que nous livrons contre les précipitations acides.

UN JOURNALISTE: Est-ce qu'il est le seul gouverneur à avoir cette façon de calculer parmi les gouverneurs qui assistaient à la conférence.

MONSIEUR ADRIEN OUELLETTE: À ma connaissance, il n'y a que monsieur Sununu qui prend cette approche pour calculer.

MR HOYTE: Could I just say that without necessarily commenting on the method of calculation, Governor Sununu shares, I think, with the other New England governors, a commitment to action which is the important point to come out of this. He quite clearly said that, regardless of any disputes about methods of calculation, we can move forward with reduction plans, and that is a much more important point to be made.

UN JOURNALISTE: Monsieur le Ministre, la population semble être davantage sensibilisée au fait que les précipitations acides causent des dommages à la forêt et à la végétation. Est-ce que l'industrie des pâtes et papiers, qui est importante au Québec, fait des pressions pour que vous deveniez plus sévères à l'endroit des pollueurs industriels?

MONSIEUR ADRIEN OUELLETTE: C'est une excellente question que vous posez là parce que, finalement, certains milieux accusent l'industrie papetière d'être responsable d'émissions de SO_2. Et il se trouve qu'elle risque, si elle est réellement coupable de ce genre d'agression contre l'environnement, d'être la première victime de ses actions.

Mais il faut mentionner que, grâce au programme de modernisation des entreprises papetières, elles sont en voie de régler ce problème et cela fait justement partie des réductions que le Québec s'est engagé à faire.

Quant à savoir si elles ont commencé à exercer des pressions sur nous, à ma connaissance, ce n'est pas de façon significative. Mais plusieurs données sont très récentes quant aux effets négatifs des précipitations acides sur les forêts. Et, au fur et à mesure que les effets deviendront évidents, nul doute que les entreprises papetières vont exercer les pressions voulues sur le Gouvernement pour qu'il intervienne, de la même façon qu'il l'a fait, par exemple, contre la tordeuse des bourgeons de l'épinette qui devenait une menace à la forêt et à leur approvisionnement en matière première.

A JOURNALIST: Mr. Hoyte, yesterday, Mr. Dukakis told us that Mr. Lewis proved to be very effective in the first mandate of President Reagan as a Secretary of Transport. So from a conservative point of view, to be effective means: deregulation. Therefore, how can a Canadian understand that statement in regard to acid rain?

MR. HOYTE: I do not think that Mr. Lewis is doctrinaire in his view with respect to deregulation. And on this issue, I think the point that Governor Dukakis wanted to make is that Mr. Lewis has proven himself able to pull together a political consensus surrounding very difficult and contentious issues within the United States, and one would hope that that kind of capability is the kind that is needed to pull together consensus on this.

I do not think, at least one would hope, and I am sure we all would agree that we hope that we will not see a doctrinaire approach to this.

JOURNALISTE: Mais pourriez-vous nous donner quelques assurances sur la sensibilité de monsieur Lewis sur la question des pluies acides, puisqu'on ne lui connaît aucune expertise jusqu'à ce jour, du moins de ce côté-ci de la frontière?

MR. HOYTE: There will be a lot of us who will be working very hard to be sure that he understands the issues surrounding acid rain. We have been, from Massachusetts and from the New England states in general and indeed the Northeastern states, very active in Washington in bringing forward a viewpoint that makes it clear that extreme damage is being caused by acid precipitation, and I think that we will press hard to help to further educate Mr. Lewis if that is necessary.

A JOURNALIST: Mr. Hoyte, based on these past two days we have heard Governor Dukakis yesterday talk about not being happy with the fact that Mr. Lewis and Mr. Davis will only be studying it for a year and he was very adamant when he said, "We want action now!"

Then yesterday, the Governor of New Hampshire was saying that the Canadians have not done as much per capita as the Americans. We have also heard talk that the U.S. Congress, right now, is the one key element as far as the Americans are concerned, that it will have to come up with some plan of legislation that would be nationally acceptable. Taking that into account, am I right in assuming that the next move is in fact up to the U.S. Congress?

MR. HOYTE: We have always been clear that movement by the U.S. Congress is critical for any overall solution, but the point that I will try to make at the outset is that it was clear at this conference that there are individual activities that can be undertaken that are

helpful toward our overall goal. I think virtually every participant representing a political entity made clear that indeed, especially in the New England states, we are doing something.

Here I believe we can move forward with specific activities within our own realms, which will be helpful, but an ultimate solution no question requires a national program within the United States, and as I have said before, a cross-international program with Canada.

A JOURNALIST: That is a national program first?

MR. HOYTE: As I have said with respect to the Easthern provinces and New England states, we are talking about a multinational program right there with which we are trying to move forward and we are not going to, I do not think, await any action by Washington before we try to develop a program that hopefully will be acceptable to governors and premiers in Eastern Canada and in New England.

A JOURNALIST: What about the western states? Can you bring them on your side?

MR. HOYTE: Pardon?

A JOURNALIST: Can you bring the western states on your side?

MR. HOYTE: Again I think the problem of NO_x is one which has been emphasized in this conference and one which is of strong importance to the western states. One of the reasons why we like to talk, at least in Massachusetts, about an overall program that includes major air pollutants, NO_x as well as SO_2, is that we think we can get stronger interest on the part of the western states if we have that kind of comprehensive plan.

UN JOURNALISTE: Monsieur Ouellette, nous pouvons lire dans le communiqué final: "Les participants ont constaté avec satisfaction qu'il existe une volonté politique d'agir". Dans ce contexte, est-ce qu'il n'aurait pas été intéressant de passer à l'étape d'un document signé conjointement par l'ensemble des participants gouvernementaux au lieu de demeurer sur une simple déclaration d'intention?

MONSIEUR ADRIEN OUELLETTE: Non, je crois que ce que vous soulignez devra faire l'objet de notre prochaine étape. Il nous apparaissait essentiel de faire le point sur un certain nombre de choses. D'abord, sur les connaissances scientifiques quant à l'état de détérioration de notre environnement, ce qui a été fait largement hier. Il nous fallait également faire le point au niveau politique sur les perceptions des vingt-deux Gouvernements sur le problème des précipitations acides. Et la phase suivante, Mr. Hoyte y a fait alllusion, est de faire rapport de cette conférence au groupe qui a été à son origine. C'est par la suite qu'il sera possible d'envisager la tenue d'une telle conférence pour passer à cette prochaine étape.

UN JOURNALISTE: Monsieur Hoyte, les études aux États-Unis portant sur les précipitations acides ont été subventionnées, par le passé, en bonne partie par les compagnies productrices d'électricité, pour la bonne et simple raison qu'il en coûte moins cher de subventionner des études que de corriger les usines concernées. Est-ce que les preuves auxquelles on en arrive aujourd'hui, vont signifier que, dorénavant, leur part dans le financement de ces études diminuera par rapport au financement public?

MR. HOYTE: I do not know about that. Certainly you are right, it is a lot cheaper to subsidize studies than to undertake action. But on the other hand, I think that what you heard at this conference was that a number of states including Massachusetts, for example, have made major commitments to research on acid rain. I expect that to continue. What the utilities and industry will do, I do not know that I can comment.

A JOURNALIST: In paragraph three of your paper, you indicated that you have enough information to have a short-term plan to cut emissions through sulphur dioxide and nitrogen oxide emission reduction programs, now. What do you mean by "now"? When?

MR. HOYTE: Again, one of the things that will be presented by the Committee of Environment of the New England Governors and Eastern Canadian Premiers at its meeting in June is a proposal for a plan for consideration. We are still in the process of developing that, but after all, June in my calculation translates into "now".

The other thing that I would say, as I have tried to emphasize before, is that there are efforts underway in individual states in the United States, as well as we have heard amongst our Canadian neighbours, to undertake programs which will be helpful in the total solution, because we need regional and national plans to have a total solution. However, the plans that we hope to submit in June are in the immediate time frame in terms of my calculations.

A JOURNALIST: Which is later this year or by next year?

MR. HOYTE: In June in St. Andrews, there is a meeting of the New England Governors and the Eastern Canadian Premiers and the Committee on Environment of that group has been charged with presenting the outlines of a possible plan or program.

I do not know whether or not what is developed is going to be accepted or will prove to be what is needed, but we feel we have enough information to develop such a plan.

UN JOURNALISTE: Monsieur Ouellette, nous avons entendu au cours de cette conférence que plusieurs États américains possèdent un plan d'inspection des automobiles. En février passé, le Québec adoptait une réglementation pour contrôler les émissions provenant des véhicules

automobiles. Est-ce que le Québec a un plan pour procéder à l'inspection des voitures ou des camions?

MONSIEUR ADRIEN OUELLETTE: Vous faites allusion aux modifications que nous avons apportées à notre réglementation. Vous êtes conscient qu'une partie de la juridiction relève du fédéral.

Pour ce qui est de l'inspection, la Sûreté du Québec sera appelée à mettre en place une surveillance pour voir au respect de notre réglementation. C'est l'équipe la mieux équipée pour le faire et c'est à elle que sera dévolu le soin de vérifier si le règlement est respecté.

UN JOURNALISTE: Oui, mais au Québec, il y a environ de deux à trois millions de véhicules. Il est certainement impossible que la Sûreté du Québec les inspecte tous. Est-ce qu'un plan est prévu, comme il en existe aux États-Unis, où les voitures devront être inspectées régulièrement?

MONSIEUR ADRIEN OUELLETTE: Si jamais le Gouvernement adoptait une politique en ce sens, cette responsabilité relèverait éventuellement du ministère des Transports. Cette question a d'ailleurs été soulevée au moment de la mise en place de l'assurance-automobile du Québec. On voulait ainsi s'assurer que les véhicules étaient en bon état et ne constituaient pas de danger pour la population en général.

Je reconnais que, malheureusement, et c'est une opinion personnelle, que ce contrôle des véhicules n'a pas encore été mis en place, mais je sais qu'on y travaille actuellement au ministère des Transports, non pas uniquement pour des raisons environnementales, mais aussi pour des raisons de sécurité publique.

A JOURNALIST: We know that the National Governors' Association has adopted a policy calling for a reduction of 10 million tons in SO_2 emissions over a 13-year period and that that policy was a basis for a piece of legislation that has since been drafted and introduced in the Senate by Senator Proxmire. Am I correct on that?

MR. HOYTE: Yes.

A JOURNALIST: That legislation has a clause concerning Canadian action, which makes American action conditional upon Canadian action. I would like to know whether that clause was suggested by the governors or was that something undertaken by Senator Proxmire. Finally, is that legislation going anywhere?

MR. HOYTE: First of all, the clause was not suggested by the governors as far as I know. I am quite sure of that.

Whether that particular plan is going anywhere, I do not know. There are a number of plans that have been or are currently in the American Congress.

What is important and what we are trying to emphasize is that, within the framework of the many plans that are being discussed, there is the opportunity to forge, if you will, a more ideal plan. That is the posture that we have been taking.

Our own delegation, in particular Congressmen Markey and Conte, has put forward legislation as well from Massachusetts. Again I believe that the framework for the development of something that can command the beginning of the national consensus is there around Congress.

A JOURNALIST: During the discussions leading up to the adoption of the policy by the National Governors was there any discussion around the need for a Canadian clause?

MR. HOYTE: I am not aware of any. I do not think there was a focus on that at all.

A JOURNALIST: Mr. Ouellette, you said earlier that you thought this conference should have some concrete results, and there seemed to be a general agreement among all of the participants that whatever Canada or the provinces or the various jurisdictions can do on their own that it will not be enough to solve the problem. From the talks I have had with the people from Illinois and Ohio and so on who are here, they do not seem to have heard anything at this conference that would convince them to change the positions that they have now.

Therefore, how do you see this concrete effort coming about in getting the people who are creating the most pollution to start doing something?

MONSIEUR ADRIEN OUELLETTE: Je pense que nous sommes tous d'accord pour admettre qu'il s'agit d'un problème transfrontalier et que la solution à ce problème international doit être elle-même internationale.

Comment peut-on arriver, dans des délais acceptables, à des actions des États qui sont responsables des émissions, sinon par le dialogue, la mise en commun d'informations détenues par chaque participant et en faisant en sorte que chaque membre soit de plus en plus persuadé qu'il y a un problème, et qu'il faut y trouver une solution.

Je vous ferai remarquer que nous avons adopté cette stratégie au Québec face au Canada et il y a à peine trois ans, nous commencions des discussions avec les autres provinces canadiennes et en moins de trois ans finalement, nous sommes arrivés à établir ce consensus. Nous avons aussi élargi ces discussions en y englobant les États de la Nouvelle-Angleterre. Et, aujourd'hui, nous avons réussi un coup de maître qui est une première en Amérique du Nord en allant chercher un certain nombre d'États à l'extérieur du groupe de la Nouvelle-Angleterre.

Cette conférence nous a permis de sensibiliser tout le monde à l'existence du problème et à la nécessité d'une intervention. Quant aux modalités d'intervention, elles demeurent évidemment la responsabilité de chaque gouvernement participant. Et comme je le disais à la fin de cette conférence, le problème n'étant pas le même nécessairement dans chacun des territoires, la solution ne sera pas la même non plus.

Nous pouvons toujours espérer résoudre uniquement le problème par réglementation ou législation. Je pense qu'il faudra aller beaucoup plus loin et analyser les conséquences que pourraient poser certains types de législation ou de réglementation dans chacun des États. Et je pense que nous avons été témoins d'exposés très éloquents à cet effet. C'est un peu comme les gens qui nous disaient: "Bien, écoutez, au Québec, si Noranda pollue, vous n'avez qu'à fermer Noranda". C'est beau, c'est facile, c'est rapide, mais il y a des conséquences économiques et dramatiques comme le chômage.

La même situation se retrouve dans les états du Mid-West américain. Il faut regarder les conséquences et trouver les solutions.

C'est finalement par des discussions que nous parviendrons à établir des solutions de rechange nécessaires qui font partie, à mon avis, de la solution et qui dépassent la réglementation et la législation.

A JOURNALIST: Could I ask Mr. Hoyte to respond to that as well? What kind of concrete progress do you see being made in terms of convincing the other states, who are not part of the team so far, to go along?

MR. HOYTE: One of the things that was outlined by Mr. Guthrie in describing the progress in the midwest was the fact of at least an agreement, conceptually, on the need for a total national plan.

We know, and it was emphasized again by Mr. Guthrie, that there are difficult economic disruptions that could impede participation by some of the midwestern states.

I certainly cannot speak for Ohio, Illinois or any other state other than Massachusetts. All I can say is that we would expect to be continuing a dialogue both individually, with some of those states, as well as through the context of the National Governors' Association and other national groups.

By the way, I am told by some others that perhaps my response was not entirely correct on when NGA asked with respect to a commensurate Canadian reduction. I guess I have to say that I am not sure, so I can correct that. I was not aware of a NGA requirement of that sort, but I am told by others that there may have been and so I just would want to correct that.

A JOURNALIST: My question is basically a follow-up on the one just asked. Mr. Hoyte, in the statement you make reference to an expression of political will on the parts of the governments towards action.

In the course of the conference, the delegations from the major producer states did a lot more listening than talking, so far as I noticed. Are you including them when you mention the political will for action?

MR. HOYTE: I certainly include all of the New England states. Moreover, I think that specific activities were identified in the presentations from the mid-Atlantic states, as well as by Mr. Guthrie in his talk about the midwestern states. Hence, in varying degrees I am including everyone.

There is strong evidence that the New England states and other states in the northeast have a firm commitment in recognition of the need for immediate action, even though there may be some pain associated with the action that is taken in those individual states.

I think the other point to be made, and it was made, is that the New England states experience very high electric rates in general and part of that is through prior programs for reduction in SO_2 emissions. It seems to me that is a demonstration of will as well.

A JOURNALIST: If I could just follow-up. Did you or other officials have discussions with the officials from the producer states, outside of the direct proceedings of the conference, that give you any reason for optimism as far as their attitude?

MR. HOYTE: No, I have not had any particular discussions here with other states.

A JOURNALIST: Mr. Hoyte, you said earlier that there is a plan being developed for presentation to the June conference. I am wondering if you can give us an idea of what eastern states and eastern

provinces are going to be asked to do, what the alternatives are that you are considering as part of that plan that you are going to be talking about in June?

MR. HOYTE: Through the Committee on Environment, we are still in the process of developing a presentation to the Governors and the Premiers.

Clearly it calls for a reduction in SO_2 emissions. However, beyond that, I do not know that I could add much.

A JOURNALIST: Obviously one of the things you are thinking about is cost sharing. We have heard some of the state governors talk about it, and in Massachusetts it would be 50 cents a ratepayer. I am wondering about the provinces. Perhaps Mr. Ouellette can talk about the kind of thing that might be discussed in June in terms of how the provinces would be sharing the cost for a regional plan.

MR. HOYTE: Again, I am not in a position to add anything beyond saying that we have been mandated to come to that meeting with a recommended plan that involves specific reductions in SO_2 emissions.

UN JOURNALISTE: M. Ouellette, quelles sont les options que vous envisagez pour le plan qui sera présenté au mois de juin?

MONSIEUR ADRIEN OUELLETTE: J'ai l'impression que vous nous précédez d'une ou de deux conférences.

UN JOURNALISTE: Monsieur Hoyte a fait référence à la conférence qui se tiendra à St-Andrews au mois de juin, où sera présenté un plan conjoint.

MONSIEUR ADRIEN OUELLETTE: La conférence qui se tiendra au moins de juin est la Conférence annuelle des Premiers ministres de l'Est du Canada et des Gouverneurs des États de la Nouvelle-Angleterre. Nous y ferons part de cette conférence qui est issue elle-même de la douzième Conférence annuelle des Premiers ministres de l'Est du Canada et des Gouverneurs des États de la Nouvelle-Angleterre.

Je souhaite que lors de cette treizième Conférence annuelle nous prenions la décision d'aller plus loin c'est-à-dire de reprendre, sous forme de conférence intergouvernementale, la problématique là où nous l'avons laissée aujourd'hui. Nous avons fait le point sur l'état de détérioration, sur la nécessité d'agir et sur le fait que le Canada et les États-Unis ont déjà fait des efforts pour réduire les émissions d'anhydride sulfureux et les émissions d'oxydes d'azote qui proviennent de l'automobile; il est maintenant temps d'aller plus loin et d'entreprendre des discussions très formelles sur le partage.

Ce que dit monsieur Sununu, par exemple, n'est qu'un élément de divergence. Monsieur Sununu est d'accord avec tout ce que je viens de dire mais il est en désaccord avec la méthode de calcul. Il nous a fallu, avec les provinces canadiennes, plus d'un an avant de parvenir à un accord sur la répartition du 50 pour cent de réduction des émissions de l'Est du Canada à savoir sur le pourcentage de réduction qui sera pris en charge par le Québec, par l'Ontario et par les autres provinces. S'il nous a fallu un an à sept provinces pour nous mettre d'accord sur le partage, j'imagine qu'une année n'est pas de trop pour établir ce partage avec les États américains.

Je souhaite la tenue d'une nouvelle conférence intergouvernementale qui traitera des possibilités de partage, de la technologie et du financement tant au Canada qu'aux États-Unis. Ce plan fait partie de notre stratégie et je pense que c'est la bonne.

UN JOURNALISTE: Pouvez-vous nous faire part des options prévues en terme de partage des coûts?

MONSIEUR ADRIEN OUELLETTE: Je crois que ceci est prématuré. Même si au Canada, nous avons déjà effectué le partage, nous connaissons les sommes d'argent que le gouvernement fédéral est prêt à investir et nous savons à quelle condition il veut le faire. Il est donc prématuré d'avancer des scénarios puisqu'il faut encore procéder à des discussions serrées avec les différentes compagnies polluantes.

Il est par exemple prématuré pour le gouvernement du Québec d'avancer le montant d'argent qui pourrait être investi car ce montant dépendra de la capacité financière de la compagnie Noranda. Il en va de même pour l'Ontario.

Nous voulons cependant vous rassurer en vous disant que le démarche est en cours, qu'elle suit un cheminement prédéterminé et que nous allons arriver à des conclusions très rapidement. Il faut faire la même chose aux États-Unis.

UN JOURNALISTE: J'ai deux questions, l'une qui s'adresse à monsieur Ouellette et la seconde à monsieur Hoyte.

Monsieur Ouellette, monsieur Piette a déclaré que le problème majeur n'était plus tellement l'acidification des lacs mais le dépérissement de la forêt. Est-ce que vous abondez dans ce sens-là?

MONSIEUR ADRIEN OUELLETTE: En fait, je pense qu'un problème n'exclut pas l'autre. Nous avons été conscients de l'acidification des lacs avant de l'être du dépérissement des érablières et du dépérissement de la forêt en général. Je pense que le second problème s'ajoute au premier, ce qui nous donne encore plus de motivation pour accélérer la

correction, enfin, pour augmenter la lutte contre les précipitations acides parce qu'au fur et à mesure que les années passent, nous découvrons des effets négatifs additionnels.

A JOURNALIST: Mr. Hoyte, are you satisfied with what Washington is doing? Are you satisfied with the actions undertaken by Washington up to now on acid rain?

MR. HOYTE: No. Governor Dukakis has indicated quite clearly that we would like to see, many of us, a firm commitment on the part of the administration to the development of a national plan and program, and not more discussion on the need for research.

On the other hand, as I have mentioned, there is a lot of activity going on on Capitol Hill which is encouraging and the ideas being discussed there perhaps provide the framework for the development of some congressional action, but we would like to see more direct commitment from the administration.

A JOURNALIST: Do you agree with Mr. Dukakis that the nomination of these two persons, Mr. Lewis and Mr. Davis, to study the situation is not advancing any more on the subject, it is just a status quo?

MR. HOYTE: I think the point that the governor was making was that one would have hoped that more than just the nomination at this point could have been done and the beginnings of some kind of agreement, an agreement on principles or an agreement on a course of action, could be had, and that was a hope. I do not think that the suggestion is that it makes no difference. It is a step, and we have all talked about the need for taking as many steps as we can. I wish it had been a few more than just naming the envoys.

A JOURNALIST: Mr. Hoyte, there has been quite a controversy about what Mr. Sununu said and Mr. Ouellette was commenting on the different way of calculating. Does this apply to other states also?

MR. HOYTE: Again I do not know that I am in a position to comment on Governor Sununu's concern about the method for calculation. We, in Massachusetts, have not emphasized that as an issue or a problem. It seems to me that what was important about what the governor had to say, and I tried to say it before, is that I thought he was quite clear that regardless of any dispute about method of calculation, there is a basis for moving forward with action. At least that is what I understood him to say and I think that is what is important about his comments.

A JOURNALIST: Do you think it was quite wise of him to come out and be so outspoken at this conference after the Reagan and Mulroney signing and then having this conference?

MR. HOYTE: Do I think it was quite what?

A JOURNALIST: Wise of him to be so outspoken?

MR. HOYTE: He is a very wise man. I do not know.

A SPEAKER: Thank you very much.

Merci beaucoup.

MR. HOYTE: Thank you.

ANNEXES / APPENDICES

ANNEXE 1/APPENDIX 1

LA CONFÉRENCE INTERGOUVERNEMENTALE SUR LES PRÉCIPITATIONS ACIDES

PROGRAMME

CO-PRÉSIDENTS Le Premier ministre du Québec, monsieur René Lévesque
Le Gouverneur de l'État du Massachusetts, monsieur Michael S. Dukakis

LE MERCREDI 10 AVRIL 1985

16 h 00 Inscription des participants
19 h 30 Dîner officiel offert par le Premier ministre du Québec, René Lévesque

LE JEUDI 11 AVRIL 1985

8 h 00 Inscription des participants
9 h 00 Présentation générale du programme
Adrien Ouellette
ministre de l'Environnement du Québec

9 h 10 Allocutions d'accueil
Le Premier ministre du Québec, René Lévesque et le Gouverneur de l'État du Massachusetts, Michael S. Dukakis

PREMIÈRE SÉANCE - Effets des dépôts acides
Président: *Hal Andrews*
ministre de l'Environnement de Terre-Neuve

9 h 30 . Influence des dépôts atmosphériques sur les écosystèmes forestiers du nord-est des États-Unis
Dudley Raynal, Ph.D.
Collège des sciences de l'environnement et de foresterie
Université de Syracuse

. Le dépérissement des érablières au Québec: problématique et état des recherches
Lise Robitaille
Ingénieur forestier, M.Sc.F.
Direction de la recherche forestière
Ministère de l'Énergie et des Ressources du Québec

10 h 30 Pause
10 h 45 Effets de l'inhalation des composés acides sur la santé humaine
Morton Lippmann, M.D.
Centre médical
Université de New York

11 h 15 L'historique et les effets aquatiques des précipitations acides dans le nord-est des États-Unis: indications à partir des sédiments lacustres et des dépôts de tourbe
Stephen A. Norton, Ph.D.
Département de géologie
Université du Maine

11 h 45 Précipitations acides et les écosystèmes aquatiques: la question de charge limite
Eville Gorham, Ph.D.
Département d'écologie et de biologie du comportement
Université du Minnesota

12 h 30 Déjeuner

DEUXIÈME SÉANCE - Relations entre la science et l'élaboration de politique
Président: *Henry G. Williams*
commissaire du ministère de la Conservation de l'environnement de l'État de New York

14 h 00 Dommages des précipitations acides en Europe: un rapport de mission de l'Association nationale des Gouverneurs
Anthony S. Earl
gouverneur de l'État du Wisconsin

14 h 30 Les actions de la Communauté européenne pour contrôler les dépôts acides
Jan Smeets
Chef de division
Prévention et réduction des pollutions
Direction générale de l'environnement
Commission des communautés européennes

15 h 00 Pause
15 h 15 Résultats et conclusions de l'évaluation par les pairs américains et canadiens des rapports scientifiques produits à la suite du Mémoire déclaratif d'intention sur le transport à grande distance des polluants atmosphériques
Hans C. Martin, Ph.D.
Conseiller principal
Bureau de liaison TADPA
Environnement Canada

15 h 45 Les implications scientifiques et économiques de la lutte aux précipitations acides
Tony Cortèse, Ph.D.
Centre pour la gestion de l'environnement
Université Tufts

16 h 30 Ajournement

LE VENDREDI 12 AVRIL 1985

TROISIÈME SÉANCE - Initiatives régionales en matière de précipitations acides
Président: *Gérard L'Écuyer*
ministre de l'Environnement et de la Sécurité et Santé du milieu de travail du Manitoba

9 h 00 . La Nouvelle-Angleterre
Wallace Stickney
Assistant spécial pour les affaires environnementales
Cabinet du Gouverneur du New Hampshire

. Les États de l'Atlantique-Centre
Henry G. Williams
Commissaire du ministère de la Conservation de l'environnement
New York

10 h 15 Pause

. Les États du Centre-Ouest
Paul Guthrie
Directeur des programmes intergouvernementaux
Ministère des Ressources naturelles du Wisconsin

. Les Provinces de l'Est du Canada
Jean Piette
Directeur des stratégies et politiques environnementales
Ministère de l'Environnement du Québec

11 h 30 Conclusions et observations finales

APPENDIX 1

INTERGOVERNMENTAL CONFERENCE ON ACID RAIN

PROGRAM

CO-CHAIRMEN Prime Minister René Lévesque
Governor Michael S. Dukakis

WEDNESDAY, APRIL 10, 1985

4:00 Registration
7:30 Official Dinner Hosted by the Prime Minister of Québec, René Lévesque

THURSDAY, APRIL 11, 1985

8:00 Registration
9:00 Program Overview
Adrien Ouellette
Environment Minister of Québec
9:10 Welcoming Address
Prime Minister René Lévesque
Governor Michael S. Dukakis

SESSION I - Effects of Acid Deposition
Chaiman: *Hal Andrews*
Environment Minister
of Newfoundland

9:30 . Influences of Atmospheric Deposition on Forest Ecosystems in the Northeastern United States
Dudley Raynal, Ph.D.
College of Environmental Science and Forestry
University of Syracuse

. Maple tree Dieback in Québec: Problems and State of Knowledge
Lise Robitaille
Forest Engineer, M.Sc.F.
Forest Research Directorate
Ministère de l'Energie et des Ressources du Québec

10:30 Refreshment Break

10:45 The Effects of Inhaled Acid on Human Health
Dr. Morton Lippmann
Medical Center
New York University

11:15 The History and Aquatic Effects of Acidic Precipitation in Northeastern U.S.: Evidence from Lake Sediments and Peat Deposit
Stephen A. Norton, Ph.D.
Department of Geology
University of Maine

11:45 Acid Rain and Aquatic Ecosystems: The Target Loading Question
Emilie Gorham, Ph.D.
Department of Ecology and Behavioral Biology
University of Minnesota

12:30 Luncheon

SESSION II - Science and Policy Relationships
Chairman: *Henry G. Williams*
Commissioner of the Department of Environmental Conservation
New York

2:00 Acid Precipitation Damage in Europe: Report on a Survey by the National Governors Association
Anthony S. Earl
Governor of Wisconsin

2:30 The European Community: Actions to control Acid Deposition
Jan Smeets
Head of Department for the Prevention and the Control of the Pollution
Commission of the European Communities (CEC)

3:00 Refreshment Break
3:15 Findings and Conclusions of the U.S. and Canadian Peer Review Panels on U.S./Canada MOI Transboundary Air Pollution Reports
Hans C. Martin, Ph.D.
Senior advisor
LRTAP liaison office
Environment Canada
3:45 The Scientific and Economic Implications for Acid Rain Control
Tony Cortese, Ph.D.
Center for Environmental Management
Tufts University
4:30 Adjournment

FRIDAY, APRIL 12, 1985

SESSION III - Regional Initiative on Acid Rain
Chairman: *Jérard L'Écuyer*
Environment and Workplace Environment Health and Safety
Minister of Manitoba

9:00 . New England States:
Wallace Stickney
Special Assistant for Environmental Affairs
Office of the Governor
of New Hampshire

. Mid-Atlantic States:
Henry G. Williams
Commissioner of the Department of Environmental Conservation
New York

10:15 Refreshment Break
. Mid-Western States:
Paul Guthrie
Director Intergovernmental Programs
Wisconsin Department of Natural Resources

. Eastern Canadian Provinces:
Jean Piette
Director for Strategic Planning and Policy Development
Ministère de l'Environnement du Québec

11:30 Conclusions and Closing Remarks

ANNEXE 2 / APPENDIX 2

LISTE DES PARTICIPANTS/LIST OF PARTICIPANTS

CONFÉRENCIERS/SPEAKERS

Lise Robitaille
Ingénieur forestier, M.Sc.F.
Service de la recherche forestière
Ministère de l'Énergie et
des Ressources
2700, rue Einstein
Sainte-Foy, Québec
Tél.: (418) 643-7994

Morton Lippman, Ph.D.
New York University
Medical Centre
Long Meadow Road
Tuxedo, New York 10987
Tel.: (914) 351-5277

Stephen A. Norton, Ph.D.
Department of Geology
Boarmand Hall
University of Maine
Orono, Maine 04469
Tel.: (207) 581-1954

Eville Gorham, Ph.D.
Department of Ecology and
Behavioral Biology
107 Zoology
University of Minnesota
318 Church S-E
Minneapolis, Minnesota 55455
Tel.: (612) 376-1743

Jan Smeets
Chef de division
Prévention et réduction des pollutions
Direction générale de l'environnement
Commission des communautés européennes
200, rue de la Loi
Bruxelles, Belgique B-1040

Hans C. Martin
Conseiller principal
Bureau de liaison TADPA
Service de l'environnement
atmosphérique
Environnement Canada
4905, rue Dufferin
Downsview, Ontario
M3H 5T4
Tél.: (416) 667-4803

Tony Cortese, Ph.D.
Centre for Environmental Management
Graves House
Tufts University
18 Latin Way
Medford, Massachusetts 02155
Tel.: (617) 381-3486

Dudley Raynal, Ph.D.
College of Environmental
Science and Forestry
University of Syracuse
Syracuse, New York
Tel.: (315) 470-6782

Paul Guthrie
Director of Intergovernmental Programs
Wisconsin Department of Natural Resources
101 S. Webster Street, GEF 11
Madison, Wisconsin 53707

Jean Piette
Directeur des stratégies et politiques environnementales
Ministère de l'Environnement du Québec
3900, rue Marly
Sainte-Foy, Québec
G1X 4E4
Tél.: (418) 643-8209

Henry G. Williams
Commissioner
NYS Department of Environmental Conservation
50 Wolf Road
Albany, New York 12233
Tel.: (518) 457-3446

Anthony S. Earl
Governor of Wisconsin
115 East State Capitol
Madison, Wisconsin 53702
Tel.: (608) 266-1212

Wallace E. Stickney
Special Assistant for Environmental Affairs
Office of the Governor
State House
Concord, New Hampshire 03301
Tel.: (603) 271-2121

CHEFS DE GOUVERNEMENT/HEADS OF GOVERNMENTS

John H. Sununu
Governor of New Hampshire
State House
Concord, New Hampshire 03301
Tel.: (603) 271-2121

Michael S. Dukakis
Governor of Massachusetts
State House
Boston, Massachusetts
Tel.: (617) 727-9173

René Lévesque
Premier ministre du Québec
885, Grande-Allée Est
Québec, Québec
G1A 1A2
Tél.: (418) 643-5321

Edward D. Diprete
Governor of Rhode Island
State House
Providence, Rhode Island 02900
Tel.: (401) 277-2080

Anthony S. Earl
Governor of Wisconsin
115 East State Capitol
Madison, Wisconsin 53702
Tel.: (608) 266-1212

DÉLÉGATION DU MAINE/DELEGATION OF MAINE

Senator Ronald E. Usher
Chairman
Energy and Natural Resources
Committee
Augusta, Maine 04333

John Kerry
Director
Office of Energy Resources
State House, Station # 53
Augusta, Maine 04333
Tel.: (207) 289-3811

John Bastey
Director of Air Bureau
Department of Environmental Protection
State House, Station # 17
Augusta, Maine 04333
Tel.: (207) 289-2437

Annee Tara
Deputy Commissioner
Department of Conservation
State House, Station # 22
Augusta, Maine 04333
Tel.: (207) 289-2211

Henry Warren
Commissioner
Department of Environmental
Protection
State House, Station # 17
Augusta, Maine 04333
Tel.: (207) 289-2811

DÉLÉGATION DU MASSACHUSETTS/DELEGATION OF MASSACHUSETTS

James Hoyte
Secretary of Environmental Affairs
100 Cambridge Street
Boston, Massachusetts 02202
Tel.: (617) 727-9800

Ken Hagg
Director
Air Quality Division
Department of Environmental
Quality Engineering
1 Winter Street
Boston, Massachusetts 02202
Tel.: (617) 292-5593

Bonnie Christie
Environmental Analyst
Federal-State Relations
State House
Boston, Massachusetts 02133

Joanne Nichols
Deputy Commissioner
Department of Environmental
Management
100 Cambridge Street, 19th floor
Boston, Massachusetts 02202
Tel.: (617) 727-3159

Elizabeth Kline
Executive Office of
Environmental
Affairs
100 Cambridge Street
Boston, Massachusetts 02202
Tel.: (617) 727-9800

Anthony Rodriguez
Department of Fish, Wildlife and
Recreational Vehicles
100 Cambridge Street
Boston, Massachusetts 02202
Tel.: (617) 727-1614

Sue Comis
Air Quality Division
Department of Environmental
Quality Engineering
1 Winter Street
Boston, Massachusetts 02202
Tel.: (617) 292-5630

DÉLÉGATION DU NEW HAMPSHIRE/DELEGATION OF NEW HAMPSHIRE

Wallace E. Stickney
Special Assistant for Environmental
Affairs
Office of the Governor
State House
Concord, New Hampshire 03301
Tel.: (603) 271-2121

Paul Bofinger
Executive Director
Society for the Protection of
New Hampshire Forests
86 Mountain Road
Concord, New Hampshire 03301
Tel.: (603) 224-4607

Norman Vandervoot
Director of Communications
Office of the Governor
State House
Concord, New Hampshire 03301
Tel.: (603) 271-2121

DÉLÉGATION DU VERMONT/DELEGATION OF VERMONT

Jonathan Lash
Commissioner
Department of Water Resources
and Environmental Engineering
State Office Building
79 River Street
Montpelier, Vermont 05602

Stephen A. Reynes
Representative
Vermont State Assembly
Box 224
North Pomfret, Vermont 05053
Tel.: (802) 828-2228

Leonard Wilson
Secretary
Coordinating Committee
Agency of Environmental Conservation
State Office Building
Montpelier, Vermont 05602

DÉLÉGATION DU RHODE ISLAND/DELEGATION OF RHODE ISLAND

Joan Marron
Department of Environmental Management
Division of Air and Hazardous
Materials
Room 204, 75 Davis Street
Providence, Rhode Island 02908
Tel.: (401) 277-2808

John Cucco
Supervising Chemist
Air Pollution Laboratory
50 Orms Street
Providence, Rhode Island 02908

Fred Vincent
Policy Director to the Governor
State House
Providence, Rhode Island 02900
Tel.: (401) 277-2080

DÉLÉGATION DU CONNECTICUT/DELEGATION OF CONNECTICUT

Stanley Pac
Commissioner
Department of Environmental Protection
165 Capitol Avenue
Hartford, Connecticut 06106
Tel.: (203) 566-2110

Chris Cooper
Office of the Commissioner
Department of Environmental Protection
165 Capitol Avenue
Hartford, Connecticut 06106
Tel.: (203) 566-2110

DÉLÉGATION DU NEW JERSEY/DELEGATION OF NEW JERSEY

Barbara Eisler
Assistant to the Deputy Commissioner
of Environmental Protection
State of New Jersey
Labor and Industry Building
John Fitch Plaza
Trenton, New Jersey 08625

DÉLÉGATION DE NEW YORK/DELEGATION OF NEW YORK

Henry G. Williams
Commissioner
NYS Department of Environmental Conservation
50 Wold Road
Albany, New York 12233
Tel.: (518) 457-3446

R. Darryl Banks
Deputy Commissioner
NYS Department of Environmental Conservation
50 Wolf Road
Albany, New York 12233
Tel.: (518) 457-5768

James Colquhoun
Coordinator
Fish and Wildlife Division
NYS Department of Environmental Conservation
50 Wolf Road
Albany, New York 12233

Harry H. Hovey
Director
Division of Air
NYS Department of Environmental Conservation
50 Wolf Road
Albany, New York 12233
Tel.: (518) 457-7230

David Shaw
Coordinator for Legislation and
Program Development
NYS Department of Environmental Conservation
50 Wolf Road
Albany, New York 12233
Tel.: (518) 457-2823

DÉLÉGATION DE PENNSYLVANIE/DELEGATION OF PENNSYLVANIA

James K. Hambright
Director
Bureau of Air Quality Control
Department of Environmental Resources
Fulton Building, 9th Floor
P.O. Box 2063
Harrisburg, Pennsylvania 17105
Tel.: (717) 787-9702

DÉLÉGATION DU MICHIGAN/DELEGATION OF MICHIGAN

William D. Marks
Assistant Deputy Director
Bureau of Environmental Protection
State of Michigan
Lansing, Michigan
Tel.: (517) 373-2347

Paul Shutt
Michigan Department of Natural
Resources
Geology Division
7150 Harris Drive
Dimondale, Michigan 48917
Tel.: (517) 322-1333

DÉLÉGATION DE L'OHIO/DELEGATION OF OHIO

Rebecca Blood
Assistant Director to the Governor
for Energy and Environmental Affairs
State of Ohio, Washington Office
444 N. Capitol Street N.W.
Suite 528
Washington, D.C. 20001
Tel.: (202) 624-5844

Charles Taylor
Chief of Division of Air
Pollution Control
Ohio Environmental Protection
Agency
361 E. Broad Street
Colombus, Ohio 43215
Tel.: (614) 466-6116

DÉLÉGATION DE L'ILLINOIS/DELEGATION OF ILLINOIS

Gayle Cozens
Deputy Governor
Conference Executive Council
Office of the Governor
100 West Randolph
Chicago, Illinois 60601
Tel.: (312) 793-2121

Don Etchison
Director
Department of Energy and Natural
Resources
325 West Adams Street
Springfield, Illinois 62706

Galen Reser
Director
Washington Office
State of Illinois
444 N. Capitol Street N.W.
Suite 210
Washington, D.C. 20001

Richard G. Semonin
Assistant Chief
Water Survey Research Center
2204 Griffith Drive
Champaign, Illinois 61820
Tel.: (217) 333-2210

Karen Witter
Office of the Governor
State House
Springfield, Illinois 62706
Tel.: (217) 782-6994

DÉLÉGATION DE L'INDIANA/DELEGATION OF INDIANA

Edward Rissing
Indiana Washington Liaison
444 N. Capitol Street
Suite 242
Washington, D.C. 20001
Tel.: (202) 783-2625

DÉLÉGATION DU MINNESOTA/DELEGATION OF MINNESOTA

John Michael Valentine
Director
Division of Air Quality
Minnesota Pollution Control Agency
Roseville, Minnesota 55113
Tel.: (612) 296-7331

DÉLÉGATION DU WISCONSIN/DELEGATION OF WISCONSIN

Robert Bartlett
Governor's Office
State Capitol
Madison, Wisconsin 53707
Tel.: (608) 266-1212

Donald Theiler
Director
Air Resource Division
Wisconsin Department of Natural Resources
101 S. Webster Street, GEF 11
P.O. Box 7921
Madison, Wisconsin 53707
Tel.: (608) 266-0603

Senator Joseph Strohl
Chairman
Senate Committee on Environment and Natural Resources
P.O. Box 7882
State Capitol
Madison, Wisconsin 53707

Jeannette Bell
Chairman
House Committee on Environment and Natural Resources
9 East, State Capitol
Madison, Wisconsin 53707

Lyman F. Wible
Administrator
Division of Environmental Standards
Wisconsin Department of Natural Resources
101 S. Webster Street, GEF 11
P.O. Box 7921
Madison, Wisconsin 53707
Tel.: (608) 266-1099

Ellen McKenzie
Governor's Office
State Capitol
Madison, Wisconsin 53707
Tel.: (608) 266-1212

Peter McAvoy
Executive Assistant
Wisconsin Department of Administration
8th Floor, GEF 11
Madison, Wisconsin 53702
Tel.: (608) 266-1741

DÉLÉGATION DES ÉTATS-UNIS D'AMÉRIQUE/DELEGATION OF THE UNITED STATES OF AMERICA

Val Descamps
U.S. Environmental Protection
Agency - Region 1
JFK Federal Building
Boston, Massachusetts 02203
Tel.: (617) 223-7210

DÉLÉGATION DE L'ÎLE-DU-PRINCE-ÉDOUARD/DELEGATION OF PRINCE EDWARD ISLAND

Don Champion
Director of Environmental Technical Services
C.P. 2000
Charlottetown, Prince Edward Island
CIA 7N8

DÉLÉGATION DE TERRE-NEUVE/DELEGATION OF NEWFOUNDLAND

David Jeans
Assistant deputy minister
Department of Environment
Tower Elizabeth
St.John, Newfoundland
A1B 1R9

Les G. Hulett, Ph.D.
Director of Industrial
Environment
Department of Environment
Tower Elizabeth
St.John, Newfoundland
A1B 1R9
Tel.: (709) 737-2554

DÉLÉGATION DE NOUVELLE-ÉCOSSE/DELEGATION OF NOVA SCOTIA

Arthur Abbot
Deputy minister
Department of Environment
Joseph Howe Building
P.O. Box 2107
Halifax, Nova Scotia
B3J 3B7
Tel.: (902) 424-2745

John Underwood, Ph.D.
Environmental Analyst
Department of Environment
Joseph Howe Building
P.O. Box 2107
Halifax, Nova Scotia
B3J 3B7
Tel.: (902) 424-5300

Moera McInnis
Executive Assistant of minister
Department of Environment
Joseph Howe Building
P.O. Box 2107
Halifax, Nova Scotia
B3J 3B7
Tel.: (902) 424-5300

DÉLÉGATION DU NOUVEAU-BRUNSWICK/DELEGATION OF NEW BRUNSWICK

Brian Barnes
Sous-ministre de l'Environnement
Case postale 6000
Frédéricton, Nouveau-Brunswick
E3B 5H1
Tél.: (506) 453-2634

Dave Besner
Directeur
Services environnementaux
Case postale 6000
Frédéricton, Nouveau-Brunswick
E3B 5H1
Tél.: (506) 453-2667

R. D. Watson
Sous-ministre adjoint
Ministère des Ressources naturelles
Case postale 6000
Frédéricton, Nouveau-Brunswick
E3B 5H1

DÉLÉGATION DU QUÉBEC/DELEGATION OF QUÉBEC

Adrien Ouellette
Ministre de l'Environnement
Gouvernement du Québec
3900, rue Marly, 6e étage
Sainte-Foy, Québec
G1X 4E4
Tél.: (418) 643-8259

Denis Samson
Directeur du cabinet
Ministère de l'Environnement
Gouvernement du Québec
3900, rue Marly, 6e étage
Sainte-Foy, Québec
G1X 4E4
Tél.: (418) 643-8259

Pierre B. Meunier
Sous-ministre
Ministère de l'Environnement
Gouvernement du Québec
3900, rue Marly, 6e étage
Sainte-Foy, Québec
G1X 4E4
Tél.: (418) 643-7860

Gérard Divay
Sous-ministre adjoint
Ministère de l'Environnement
Gouvernement du Québec
3900, rue Marly, 6e étage
Sainte-Foy, Québec
G1X 4E4
Tél.: (418) 643-7860

Jean Piette
Directeur des stratégies et
politiques environnementales
Ministère de l'Environnement
Gouvernement du Québec
3900, rue Marly, 3e étage
Sainte-Foy, Québec
G1X 4E4
Tél.: (418) 643-8209

DÉLÉGATION DE L'ONTARIO/DELEGATION OF ONTARIO

Walter Giles
Assistant Deputy Minister
Ministry of Environment
135 St-Clair Avenue West
Toronto, Ontario
M4V 1P5
Tel.: (416) 965-5115

Karen Sadlier-Brown
Counselor on Policies
International Relations
Ministry of Intergovernmental
Affairs
Mowat Bloc, Queen's Park
Toronto, Ontario
Tel.: (416) 965-3356

DÉLÉGATION DU MANITOBA/DELEGATION OF MANITOBA

Gérard L'Écuyer
Ministre de l'Environnement et
de la Santé et Sécurité du milieu
de travail
Édifice 2, B.7
139, Tuxedo Avenue
Winnipeg, Manitoba
R3C 0V8
Tél.: (204) 945-2587

Norm Brandson
Directeur du Service de la
gestion de l'environnement
Ministère de l'Environnement et
de la Santé et Sécurité du
milieu du travail
Édifice 2, B.7
139 Tuxedo Avenue
Winnipeg, Manitoba
R3C 0V8
Tél.: (204) 945-1954

DÉLÉGATION DU GOUVERNEMENT DU CANADA/DELEGATION OF GOVERNMENT OF CANADA

John A. Fraser
Ministre
Ministère des Pêches et Océans
200, rue Kent
Ottawa, Ontario

Jacques Gérin
Sous-ministre
Environnement Canada
Terrasses de la Chaudière
28e étage
10, rue Wellington, Tour du Nord
Hull, Québec
K1A 0H3
Tél.: (819) 997-4203

Claude Boisselle
Chef de cabinet du Ministre
des Pêches et Océans
200, rue Kent
Ottawa, Ontario

Gilles Lamoureux
Directeur régional
Environnement Canada
Région de Québec
1441, route de l'Église
Sainte-Foy, Québec

DÉLÉGUÉS D'ORGANISATIONS INTERGOUVERNEMENTALES ET INTERPARLEMENTAIRES/ DELEGATES OF INTERGOVERNMENT AND INTERPARLIAMENTARY ORGANIZATIONS

Pamela G. Wiley
Executive Director
Council of Great Lakes Governors
122 West Washington Avenue, Suite 801A
Madison, Wisconsin 53703
Tel.: (608) 255-7880

Ned Helm
National Governors' Association
Hall of the States
444 North Capitol Street
Washington, D.C. 20001

William Gildea
New England Governors' Conference
76 Summer Street
Boston, Massachusetts 02135
Tel.: (617) 423-6900

Charles Fausold
New England Governors' Conference
76 Summer Street
Boston, Massachusetts 02135
Tel.: (617) 423-6900

Jane Spurr
Coordonnatrice régionale
Secrétariat canadien des Provinces
de l'Est
Halifax, Nouvelle-Écosse
B3J 2Z1
Tél.: (902) 424-5905

F.W. Becker
State and Territorial Air
Pollution
Program Administration
444 N. Capitol Street N.W.
Suite 36
Washington, D.C. 20001
Tel.: (202) 624-7864

Michael Bradley
Executive Director
Northeast States for Coordinated Air Use Management
Boston College
Weston Observatory
Weston, Massachusetts 02193
Tel.: (617) 437-9007

Jan Smeets
Chef de division
Prévention et réduction des pollutions
Direction générale de l'environnement
Commission des communautés européennes
200, rue de la Loi
Bruxelles, Belgique B-1040

Charles Tretter
New England Governors' Conference
76 Summer Street
Boston, Massachusetts 02110
Tel.: (617) 423-6953

AUTRES DÉLÉGUÉS GOUVERNEMENTAUX/OTHER GOVERNMENT DELEGATES

Barnett Danson
Consul général du Canada à Boston
500 Boylston Street
5th Floor
Boston, Massachusetts

Marcel Socqué
Conseiller en relations intergouvernementales
Bureau du Québec
112, rue Kent
Ottawa, Ontario
Tél.: (613) 238-5322

Jeffrey Wolf
Environmental Advisor
Embassy of the United States of America
Ottawa, Ontario

Georges Rejohn
Deputy to Mr. William Davis
Ottawa, Ontario
Tel.: (819) 992-0760

INDEX DES CONFÉRENCIERS/SPEAKERS INDEX

	PAGE
Cortese, Tony	159
Dukakis, Michael S.	11
Earl, Anthony S.	117
Fraser, John A.	107
Guthrie, Paul	219
Gorham, Eville	91
Hoyte, James	281
Lévesque, René	3
Lippmann, Morton	61
Martin, Hans C.	143
Norton, Stephen A.	75
Ouellette, Adrien	275
Piette, Jean	243
Raynal, Dudley	23
Robitaille, Lise	43
Smeets, Jan	129
Stickney, Wallace E.	201
Sununu, John H.	99
Williams, Henry G.	209